Engineering Library

JUL 3 1933

ELECTRICAL WORLD

ENGINEERING WILL NOT SUCCUMB TO INDUSTRIAL SOCIALIZATION

. . . This was Engineers' Week at the Century of Progress Exposition. Assembled under the banners of their professional societies, the engineers met to gain unity, to record progress and to pay honor to deserving associates.

. . . Technical contributions were numerous and valuable. New styling, new materials, new apparatus and new economic assemblies attested to the inexhaustible resources engineers can and do produce in their researches and inventions. Contrary to general impressions technical contributions are more numerous and more valuable as well as disturbing than at any time in the past.

. . . But these meetings were not concerned wholly with the mechanics of the art. The engineers gave expression to a greater concern for the economic and social results of their work. They were interested in men as well as machines. They sought to increase the professional status of engineers and to contribute of their thought and action to problems involving human welfare.

. . . The engineers combat socialized governmental economics. They will not yield to pleas for a cessation of industrial and technical development. They seek to readjust human and industrial affairs so that progress may be had through a more logical balancing of activities. They know the world can be made more prosperous and more interesting and that human activities may be broadened through engineering contributions. Engineers will continue to conquer the unknown.

JULY 1, 1933

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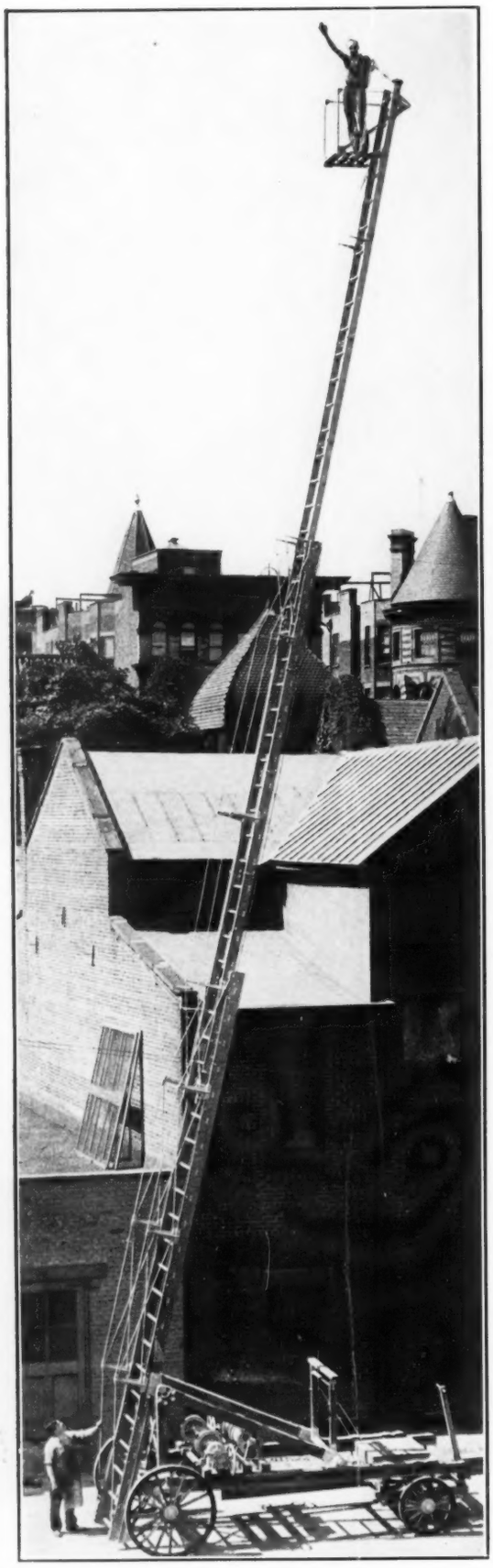

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ELECTRICAL WORLD

A consolidation of Electrical World, Electrical Engineer and American Electrician

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What in the World!

Business is better. Tangible proof exists that buying and selling are occurring in volume that is very encouraging. Yet we met a manufacturer recently who didn't know this. He had been sitting in his office for a year, he had fired his sales staff and he had quit reading business papers. There are others in this class. We wonder if they ever will get or even deserve increased business.

•

A sigh of relief was heard when Congress adjourned. Now the task is to turn legislation into practice. The industrial recovery act will quickly weigh theory against actuality and we envy neither the governmental nor industrial administrators of the act. They have a job on their hands.

•

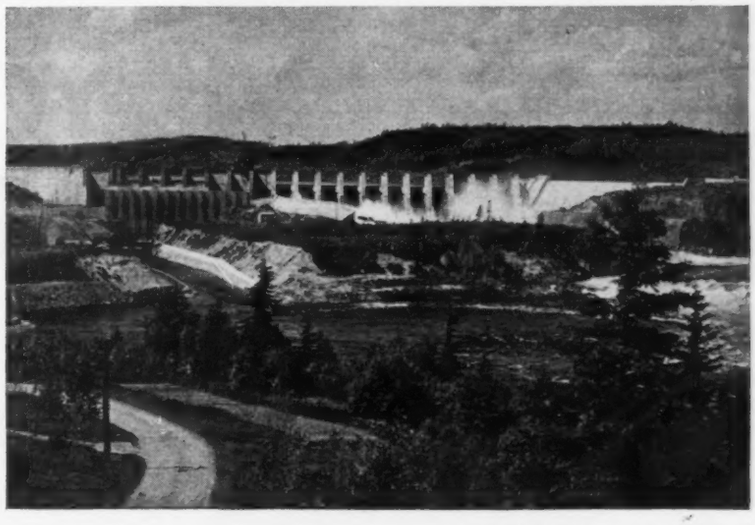
Summer doldrums or slumps are not necessary and evidence is very strong that neither the administration nor industry can afford to let down this summer. There must be steady upward progress to avoid a disastrous relapse, for it is well to remember that the basic reason for good business as well as bad business is the psychology of the public.

•

This was engineers' week at the Century of Progress. They set forth their views on economics and sociology and presented valuable technical contributions. Even though we do not grant them competency in their discussions of the broader aspects of life, it is an encouraging sign to find them even recognizing that technical competency alone will not advance human welfare.

•

To be in accord with our opinion about the summer, we are very busy planning work instead of planning vacations. Engineering, sales, construction and organization articles will be published that will help readers capitalize upon new conditions. We turn to expansion and are glad to forget the incessant pressure to economize.



260,000-hp. Chute-à-Caron development

JULY 1, 1933

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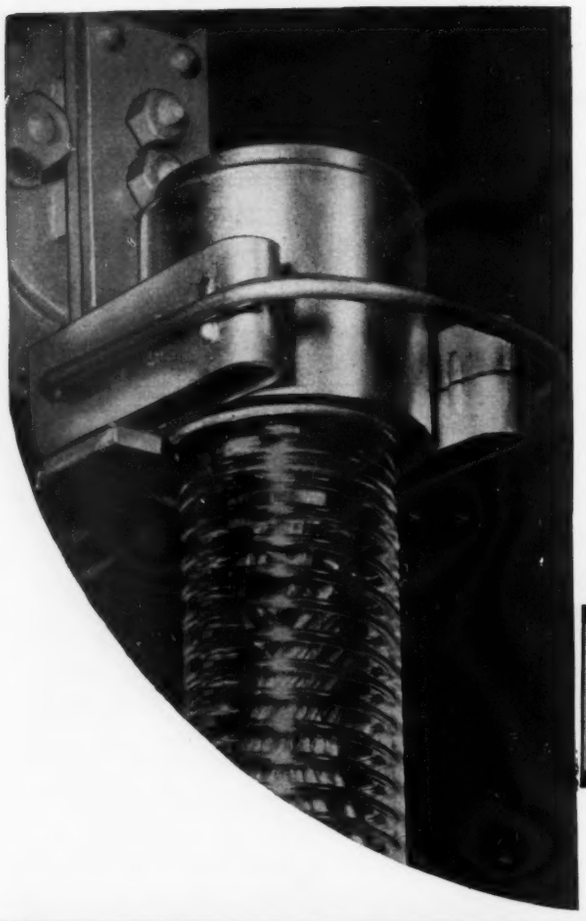

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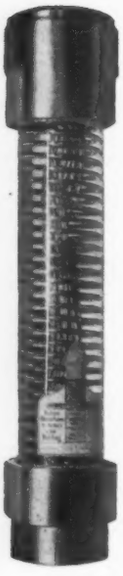

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ELECTRICAL WORLD

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for the Week Ending

July 1, 1933

Engineers' Week at Century of Progress

Conventions of engineering societies held this week in Chicago included: A. I.E.E., A.S.M.E., A.S.T.M., S.P.E.E., I.R.E.

Whitehead elected president of A.I.E.E.

Improved mercury-vapor boiler announced.

10,000,000 volts for research.

CONTINUED PROGRESS in engineering development work, announcements of important departures from accepted practices and rewards to those who have been prominent in the advance of the art featured Engineers' Week at the Chicago Century of Progress Exposition.

Many of the important professional engineering societies met there this week, including the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, the American Society for Testing Materials, the Institute of Radio Engineers, the Society for the Promotion of Engineering Education and the Econometric Society. A feature of Engineers' Day was the awarding to the Spanish engineer Juan de la Cierva, inventor of the autogyro, of the Daniel Guggenheim medal.

At the A.I.E.E. summer convention honorary memberships were awarded to W. L. R. Emmett, Edward Weston, R. A. Millikan, E. W. Rice, Jr., A. E. Kennelly and G. A. Hamilton.

The Lamme medal was presented to Edward Weston. Prize awards were made to President-elect J. B. Whitehead and Dean R. E. Doherty.

10,000,000-volt generator

Notable advance in research was foretold by President Karl T. Compton of the Massachusetts Institute of Technology, who described the latest De Graaff type of generator now installed at Round Hill, Mass. Put in operation a few days ago, Dr. Compton said the electric monster has, on its first trials, let loose 6,000,000 volts of electric potential, the greatest steady potential so far achieved artificially. When changes have been made in the surrounding structure the full 10,000,000 volts will be available.

Announcement was made by W. L. R. Emmett, developer of the mercury-vapor boiler-turbine unit used so successfully at Hartford and now assuming regular operation at Kearny and about to be placed in use at Schenectady, that he had completed the evolution of a simple and relatively inexpensive boiler for the mercury process which would give this method of power generation a further advantage over present widely used steam and hydro plants. Messrs. Rice, Kennelly and others who were honored were unanimous in predicting further early electrical developments which would, through invention and research, bring new economies, uses and broader applications.

Prof. J. B. Whitehead of Johns Hopkins University, known for his researches in dielectrics and activities in standardization work, was elected president of the American Institute of Electrical Engineers for the coming year.

President Charlesworth of the A.I.E.E. in his address emphasized the necessity for all engineers to assume larger social, political and economic responsibilities.

Section delegates met for two days and passed resolutions favoring the development of student branches for colleges with evening and night courses in engineering. Technical sessions were well attended and several new developments were announced, including a low-voltage compression type of breaker. Visits to the fair and the usual social features were enjoyed by the 600 in attendance.

A.S.M.E. discussed power

Outstanding at the meeting of the American Society of Mechanical Engineers were papers giving test data on large condensers and boilers and those discussing feedwater problems. At a joint meeting D. W. Mead presented a paper on St. Lawrence power and waterway, advocating single-stage development. This was contrary to present agreements and progress and caused discussion of interest. W. S. Lee described the great development at Beauharnois.

At a joint meeting with the Econometric Society a notable paper was presented by Dean Kimball, who discussed the engineering economist of the future. So many important meetings were held that many engineers commented upon the three-ring circus effect and the impossibility of being in several places at one time. Undoubtedly Engineers' Week at the fair was successful from an attendance and publicity point of view.

State boards of engineering examiners met to discuss licensing laws, proposed changes in the constitution of the association and the development of the certification plan for engineers. Educators met under the auspices of the Society for the Promotion of Engineering Education.

▼

Range Rentals Considered by Pacific Coast Utilities

Several independent investigations of the revenue possibilities of range and water heater rentals are being made by Pacific Coast power companies. To date the Turlock Irrigation District is the only utility organization which has included the rental plan as a definite part of its business development program (ELECTRICAL WORLD, May 13, page 596).

Another power company, however, has ordered 50 ranges for experimental installation in various sections of its territory. This utility plans a basic rental charge of $2 per month with no charge for installation. The plan provides for outright purchase by the consumer within two years should he desire to do so by crediting 75 per cent of the rental paid in to the original purchase price. Consumers purchasing ranges under this provision will be charged with 75 per cent of the cost of the wiring installation.

Still another utility is considering the idea of renting 1,000 ranges with in-

stallation made by its own line crews, which are on short working time at present. A third company, with some 2,000 Red Seal homes, which already have the range wiring provided, or homes in which ranges have been displaced by other fuels or repossessed, is making an intensive study of the range-rental idea.

Several companies also are working on the idea of renting water heaters. A leader in this idea is the British Columbia Electric Railway Company, Ltd., which has initiated the policy of giving away water heaters to those consumers who have ranges installed (ELECTRICAL WORLD, April 1, page 409).

▼

Rocky Mountain Units Frame Merchandising Code

Out of many conferences between representatives of the retail hardware trade and the gas and electric utility companies of Colorado, New Mexico and Wyoming has come a code accepted as the basis for future merchandising practices and principles in electric and gas appliance sales. Though subject to change, modification or amendment, as conditions warrant, it is basic.

Organizations co-operating were: Mountain States Hardware and Implement Association, Rocky Mountain Electrical Association, Colorado Society of Sanitary and Heating Engineers and Electrical League of Colorado.

It is provided that——

1. All appliances offered for sale should be of standard makes, and quality, preferably of American manufacture.
2. Premiums or free merchandise should not be offered to induce sales, except when included in national selling plans of manufacturers.
3. All dealers should discourage free trials or demonstrations on all appliances which have a reasonable customer acceptance.
4. All dealers should sell appliances that have reasonable customer acceptance, at prices arranged to return fair profit.
5. The effort of all factors in gas and electrical appliance distribution should be to eliminate credit terms as a basis of competition.
6. Carrying charges be not less than one-half of 1 per cent per month, applied to balance remaining after down payment.
7. The maximum payment period for major appliances, such as electric ranges, refrigerators, automatic heaters and house-heating equipment, should be 24 months.
8. On trade-in allowances the loss on the resale of the article traded in should not exceed 5 per cent of the established retail price of the new article sold, except when included in national selling plans of manufacturers.
9. On the sale of any appliances retailing for less than $10 (except automatic irons selling for $5 or more) and on other items sold on open charge account, billing should be net 30 days, or when sound credit and effective sales promotion allow, net 60-90 days.
10. All merchandise carry only the manufacturer's guarantee.
11. All advertising and other representations to the purchaser should be in conformity with these principles.

Utilities' place defined

1. Utilities should not make reference to the fact that merchandise payments can be made with monthly bills for gas or electric service.
2. As a co-operative measure utilities should include, in monthly statements for service, advertising for the benefit of all dealers.
3. Sales of major appliances should be confined to those communities where gas or electric service is provided by the utility.
4. No appliance or merchandise not directly related to the use of gas or electricity should be sold by utilities.
5. Utilities should design some of their advertising to permit all other dealers to tie in with or otherwise benefit from it.
6. To promote public acceptance of newly introduced gas or electrical appliances, the utilities should present to the public such devices on a promotional basis, not a merchandising basis.
7. Where installation costs are borne in whole or in part by a utility in connection with its merchandise sales, the same plan should be extended by the utility on similar sales by other retailers.
8. It is for the common good that adequate financing service for installment sales shall be available to all established retailers.

▼

Water Cooling of Concrete Adopted for Boulder Dam

Estimating that were natural conduction of the heat generated by the concrete forming the Boulder Dam to be relied upon for cooling it would "require centuries to get rid of the excess heat without artificial aid and the process would result in dangerous open joints or cracks," engineers are relying upon artificial cooling processes.

As fast as the concrete is poured 2-in. iron pipe is installed at 11½-ft. intervals, through which cold water will be circulated. Concrete rises about 40 deg. in temperature after setting. There will be about 150 miles of such pipe imbedded in the dam.

A similar system was tried on a smaller scale in the Owyhee Dam in Oregon. By pumping 64-deg. water through pipes the temperature was reduced from 118 deg. to 84 deg. in two weeks.

▼

I am very sure that no technique exists, even in theory, through which, by means of credit and currency manipulation, we can reach a particular price level and hold it. The worst possible thing that the world could get into would be a welter of inconvertible paper moneys in the main commercial countries, none of them anchored to gold, none trusted by the nationals of other countries, fluctuating in their relations day by day, introducing an incalculable speculative risk into every transaction, foreign or domestic.

BENJAMIN M. ANDERSON,
Economist, Chase National Bank.

[Mr. Anderson recently addressed the Pilgrims of the United States at a dinner given in honor of Sir Josiah Stamp.]

▼

New Photo-cell Brings Television Nearer Practical

Described by the inventor, Vladimir K. Zworykin of the R.C.A.-Victor Company's research laboratories, before the Institute of Radio Engineers in Chicago this week, a new photo-cell device for television has been generously hailed as bringing television for the home to the point of practicality. The "iconoscope" or image-observer is essentially an artificial eye with retina, rods and cones, nerves leading to the brain, and brain.

According to Dr. Zworykin, the invention works upon an entirely new principle which he has been developing for ten years and its present efficiency is 7,000 times greater than that of other systems, when working only at 10 per cent of its possible output. A 100 per cent output, Dr. Zworykin said, will give it 70,000 times the efficiency of the older systems.

Microscopic photo-cells

One of the important parts of the artificial eye, substituting for the millions of rods and cones behind the human retina, consists of 3,000,000 photo-electric cells, or "electric eyes," the nature of which is kept a secret. These cells are so small that they can be seen only under a microscope. So minute are they that 10,000 of them are crowded into the space of one square centimeter. The entire 3,000,000 photo-cells are held in a mica sheet four by five inches and the whole inclosed in a vacuum tube sixteen inches long with a bulb eight inches in diameter.

One of the remarkable features of the artificial eye is that it has "memory," being able to retain images of light and transmit them undiminished to the artificial brain or "kinescope."

An electron beam covers the 3,000,000 cells of the mosaic 24 times a second. This action is as fast as that of a motion-picture camera.

▼

Refrigerator Sales Records Broken, Institute Reports

Sales of household electric refrigerators in the United States in May broke all records for a single month, according to the electric refrigeration bureau of the Edison Electric Institute. Total sales for the month through all retail outlets are estimated at 212,770 units, against 127,917 sold in April this year and 131,-

946 in May, 1932. In the entire first four months of this year 240,560 were sold.

The May total exceeds by approximately 36 per cent that of April, 1931, which was the biggest previous month on record, the total for that month being 156,248 units.

Total sales in first five months of this year are estimated at 453,330 units.

▼

Advertise Well to Sell, Utility Association Is Told

"Public utilities of this country which do not use newspaper advertising consistently and continually are making a mistake which no amount of promotion in other fields can rectify," Wesley A. Gilman, vice-president of N. W. Ayer & Son, this week told the Public Utilities Advertising Association convention.

"A study of a large amount of utilities advertising during the last few years," Mr. Gilman continued, "has convinced me that your greatest need is to apply more imagination to the advertising work that you are doing. Too many utilities are satisfied with placing an illustration of an appliance in a newspaper with a mere listing of prices. This type of advertising does an inefficient job of selling, in the first place, and secondly, it contributes nothing whatever to building good will.

"The first and most important job to be done is to tell the public what the utility is and what it does. It is time that utility advertising be done with complete frankness, candor and honesty. Your advertising also must be intelligent. It is not enough to be forthright if the public finds your forthrightness dull reading. You must study and learn the psychology and the temper of your people before you can convince them.

"The necessity for advertising in the field of utility appliances certainly needs no justification or excuse. Without advertising it would have taken twenty years to sell as many automatic refrigerators as have been sold in the last five years. The washing machine, the electric clock, the iron, the toaster and many other appliances would still be curiosities. Advertising can do the pioneering job. The trouble is that there is so little of it, and that so much of what there is is ineffective.

"The utilities do not need a cure-all or a strikingly new idea. What they do need is to raise their promotional activities to a reasonably high level. When this is done the industry will begin to capitalize upon its possibilities for appliance sales, load building and good will."

T. K. Quinn addresses advertisers

Freedom of the people from poverty, especially disability, unemployment and old-age destitution, were defined as prerequisites to advertising and salesmanship in America by T. K. Quinn, vice-president of the General Electric Company, in speaking today before the 29th annual convention of the Advertising Federation of America. When the conditions which he laid down have been met, Mr. Quinn pointed out, then the public will be possessed of permanent purchasing power, and advertising and salesmanship can go to work to teach people "to want better and more abundant living.

"It is to be expected," said Mr. Quinn, "that men will work for enough to supply actual needs, but whether we are to go beyond mere necessities depends upon wants. The law doesn't attempt to make people want things. That is a sales job. As consumers we face eternal choices among many alternatives, according to wants and needs which are in constant competition with each other. Is it necessary to say here that as long as such choices are left to us, the way for advertising and selling is left open, however many laws are passed? The work of creating and raising the level of wants is an added great opportunity."

Did Any One Test the Brakes?

Wheat passes the dollar mark. Commodity prices average the highest in the past eighteen months. Steel output is at 50 per cent of capacity. Automobile production is at the high point of the year. Energy production reaches to all-time peaks on several properties. Car loadings sweep upward. Textiles are on a higher output base than at any time since 1929. Security markets continue their wayward skyrocketing.

To sustain such feverish activity after a long and debilitating illness it is necessary that the patient receive powerful stimulants. Hence the rush to have the first of the industry control bills accepted; to have Administration hands at the World Economic Conference unfettered by stabilization agreements; to put men to work, and to further discredit the dollar, which, were deliberately destructive policies not pursued, would probably go back to its old par.

How far the mad rush will go is beyond hazardous estimate by even the best informed and courageous. Such momentum as is now gathering may carry America back to 1929 levels in relatively brief time—and Nemesis just around the corner. That the course is perilous beyond all conscience is the lesson of the ages.

▼

Agricultural Engineers Find Broader Energy Use

Electrical energy, long a welcome aid to the farmer for power, heat and light, is continuing its incursions into this market. At the annual meeting of the American Society of Agricultural Engineers in Lafayette, Ind., last week a number of new and promising uses were mentioned and further developments foretold.

Papers and committee reports covered a wide range of topics in the farm electrification field, including electric soil heating, general-purpose farm refrigerators, motor control and protective devices, household electric equipment, uses of electric light in stimulating plant growth, controlling insects and treating livestock and poultry, new wiring materials and methods, electric brooders and electric equipment for use in farm storage buildings.

Wider applications of electric soil heating, development of electric soil and dairy utensil sterilizers, a new type of electric latent steam boiler for use in farm dairies and the appearance of an electric tractor on the market in Italy were cited by George W. Kable, director of the National Rural Electric Project, as outstanding recent developments in farm electrification in his discussion of that subject before the convention.

Electric soil heating, while introduced in this country only a few years ago, is now being applied in growing more than 50 kinds of crops on truck farms, in greenhouses and nurseries, according to Richard Boonstra, agricultural engineer of the Public Service Company of Northern Illinois.

Stimulated plant growth

Results of experiments at Purdue University, reported by R. B. Withrow of the agricultural experiment station of that institution, on the use of electric lights in greenhouses indicate that low light intensities are as effective as higher intensities, that red light is most efficient and that the time in the life of the plant when the lights are applied is important.

The stationary spray plant and mechanically cooled apple-storage house at the Coffing Brothers' 260-acre apple orchard near Silverwood, Ind., were inspected on the last afternoon by many of those attending the convention. A total of 72 hp. in electric motors was found to be installed to drive the spray machinery, refrigeration equipment, water pump and fruit sizer.

▼

Narragansett Electric Finances

First utility issue to be marketed under the rules laid down by the new security act, a $3,000,000 offering of Narragansett Electric Company 5s, was sold at 98¼ this week by a syndicate headed by the First of Boston Corporation in a short time. Descriptive circulars produced even greater interest in security centers than did the bonds.

Coming Meetings

Illuminating Engineering Society—Delavan, Wis., August 28-31. D. W. Atwater, 29 West 39th St., New York.

International Association of Electrical Inspectors—Chicago, Ill, September 11-15. V. H. Tousley, 612 No. Michigan Avenue, Chicago.

National Electrical Exposition—New York, N. Y., September 20-30. Ralph Neumuller, 480 Lexington Ave., New York.

National Association of Railroad and Utilities Commissioners — Cincinnati, Ohio, October 10-13. James B. Walker, 270 Madison Ave., New York.

Association of Iron and Steel Electrical Engineers — Pittsburgh, Pa., October 17-19. John F. Kelly, Empire Building, Pittsburgh.

▼

Nebraska Association Joins Missouri Group

Formally voting to sever all ties with the late National Electric Light Association, the Nebraska Electric Association, one-time N.E.L.A. section, has affiliated itself with the Missouri Valley Electric Association.

At the annual meeting, on June 22, G. W. Swift, president of Western Public Service Company, was elected president and J. R. Jaquet of Nebraska Light & Power vice-president.

Discussions at the meeting centered largely upon the hydro-electric projects being pushed by local communities under the provisions of a new federal law. Speakers presented the plans of each of these proposed developments and explained their significance for the existing power companies. While the reaction to these proposals of those in attendance was that they were fantastic as a whole, it was conceded inevitable that several of them would be constructed. In all cases the existing power companies are being depended upon to purchase energy production, but in none of them is any provision made for the necessary standby equipment that either the private or public corporations must furnish in order to insure continuous service. The total production, it was pointed out, would be several times the amount now being consumed in the state.

▼

Foundrymen Protest Present Energy Schedules

Assailing existing industrial energy rate schedules, a joint committee of the Steel Founders' Society, Grey Iron Institute and Malleable Iron Research Institute reported its findings at a "Conference on Electric Power Costs in the Foundry" at a meeting last week previous to the opening of the American Foundrymen's Association in Chicago. This committee set forth twelve indictments of industrial rates. These included the insistence by the power companies on the payment of demand charges, methods of determining demand, ratio of demand charges to annual charges, off-peak and unlimited service, minimum bills, power factor clauses, coal clauses, terms of contracts, parallel operation of customers' plants with utility systems, combination—or, rather, too frequent lack of combination — of lighting, power and heating services in a single rate, ownership of transformers, and discounts.

The report of the committee on its survey of power costs in foundries consisted of a tabulation of 129 replies to questionnaires from all over the country. These showed a prevalence of higher costs for foundry power in the industrial regions of the North and East, with lower costs and fewer foundries in the South and West. The tabulation exhibited kilowatt-hour costs calculated from submitted rate schedules varying from 0.0078 to 0.0299 cents for unlimited service with 0.005 cents as the minimum for off-peak supply. Percentage of total bill represented by demand charge ranged from zero to 100 and percentage of power cost in price of castings from 3 to 38.

▼

Grand Coulee Project Sure, Washington Senator States

Declaring that construction of the Grand Coulee Dam of the Columbia Basin project by the federal government is certain in the near future, Senator Clarence C. Dill announced on his return here from Washington, D. C., that he has received word from President Donnelly of the Northern Pacific Railway that engineering and traffic surveys preliminary to the construction of a branch line to the dam site will be started immediately. Dill pointed out that if the state puts up money for engineering surveys at the dam site actual construction of the dam with federal public works funds would be started in the spring.

Addressing the Advertising Club of Spokane, Senator Dill said: "I come home to tell you that President Roosevelt proposes to build this dam, the government is going to help us build it. Some say there is more power being produced now than we can sell from the Coulee plant. Of course there is, and why? Because of the profiteering prices charged by the power trust subsidiaries that are paying dividends on watered stocks."

"Public utilities must give maximum service at minimum rates or private ownership will be past history in Washington." This was the declaration of Gov. Clarence D. Martin speaking before the Spokane Chamber of Commerce members last week. Governor Martin said further: "In this state, in which there are natural resources with a sixth of the water power in the United States, we should have cheap power. If it is not worked out private ownership is going to be past history. If rates should be lower we are going to lower them or fight to the finish."

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N.E.M.A. Industry Code May Be Drawn Soon

Not only has a committee been appointed to draw up an industry code for the National Electrical Manufacturers' Association, but it is prepared to act soon in presenting recommendations. Conferences have been held with General Johnson and his staff in connection with preliminary suggestions. It is thought that a code may be presented to the Administration on behalf of the electrical manufacturing group early this month.

Following conversations with General Johnson and his staff in Washington late last week, J. S. Tritle, vice-president and general manager of Westinghouse Electric & Manufacturing Company and president of N.E.M.A.; Francis E. Neagle, general counsel of N.E.M.A., and A. W. Berresford, managing director N.E.M.A., returned to New York to meet with the board of governors to formulate a code.

At the Washington conference a series of suggestions was presented to General Johnson and his staff for criticism and comment as a guidance for the formulation of a code to govern the industry. These suggestions were presented to the board of governors of N.E.M.A. at an all-day meeting. The board then appointed a committee to draw up a code to be later submitted to the board for approval before it is submitted to the Administration.

The committee appointed to draw up the code included Mr. Tritle, Frank C. Jones, president of Okonite Company; George Mason, president of Kelvinator, Inc., and C. L. Collens, president Alliance Electric & Engineering Company.

At the annual meeting of N.E.M.A. in May the members voted authority to the board of governors to formulate an industry code in accordance with such principles as might be set forth in the national industrial recovery act (ELECTRICAL WORLD, May 27, page 658, and June 3, page 710).

▼

Kearny Takes Full Load

Following a period of operating adjustments, remedying of boiler leakage and minor reconstruction the 20,000-kw. mercury-vapor boiler-turbine unit at Kearny station of Public Service Electric & Gas Company assumed full load for the first time late last week. The unit was placed in preliminary operation

late in March (ELECTRICAL WORLD, April 1, page 406). The General Electric Company's own installation in an outdoor generating station at Schenectady has not, it is reported, been placed in operation.

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Louisville Utility Simplifies Set-Up

Dissolution of the Kentucky Coke Company has been ordered by the directors of that company and the Louisville Gas & Electric Company, it is announced. The coke company's properties were transferred to the gas and electric company.

This step is the first in the promised simplification of the corporate structure of the gas and electric company, whose complex structure was the cause of much criticism in rate negotiations during the last year (ELECTRICAL WORLD, February 18, page 213). Other consolidations are to be made shortly, according to President T. B. Wilson.

Mr. Wilson states that since the Louisville Gas & Electric Company of Kentucky will own and operate various leased properties after the transfer has been made, leases and agreements in effect between that company and the coke company will be canceled.

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Salary Lists Included in New York Hearing

In a continuing search for sensations, witnesses before the New York Public Service Commission late last week introduced additional evidence into the record. After a long battle the official records of just what the more important executives of the electrical group of Consolidated Gas properties received was revealed.

These were as follows: F. W. Smith, president of New York Edison, $75,000 (from three companies); Philip Torchio, senior vice-president New York Edison, $40,000 (from two companies); Robert B. Grove, vice-president, $35,000 (two companies); William W. Erwin, vice-president, $25,000 (two companies); A. H. Kehoe, vice-president, $25,000 (two companies); R. H. Tapscott, vice-president, $25,000 (two companies); Joseph F. Becker, vice-president, $20,000 (two companies); E. H. Rosenquest, president Westchester Lighting Company, $35,000 (three companies); E. P. Prezzano, vice-president Westchester, $22,000 (three companies), and Stuart Wilder, vice-president, $16,000 (three companies).

Officials connected with but one organization were listed as follows: New York Edison, Floyd Carlisle, chairman of the board, $25,000. New York & Queens Electric Light & Power, president, H. L. Snyder, $25,000. Brooklyn Edison, president, John C. Parker, $45,000; vice-president and general manager, W. F. Wells, $37,500; vice-president, W. P. Holcombe, $25,000; George L. Knight, $20,000; H. R. Woodrow, $20,000. Westchester Lighting, F. A. Stratton, chairman of the board, $30,000. Total administrative salaries of the system companies, $951,652.

Asked what relevancy the exhibits might have on the present rate case, Chairman Maltbie of the commission replied: "These exhibits show the extreme emergency which exists."

Long Island Lighting write-up

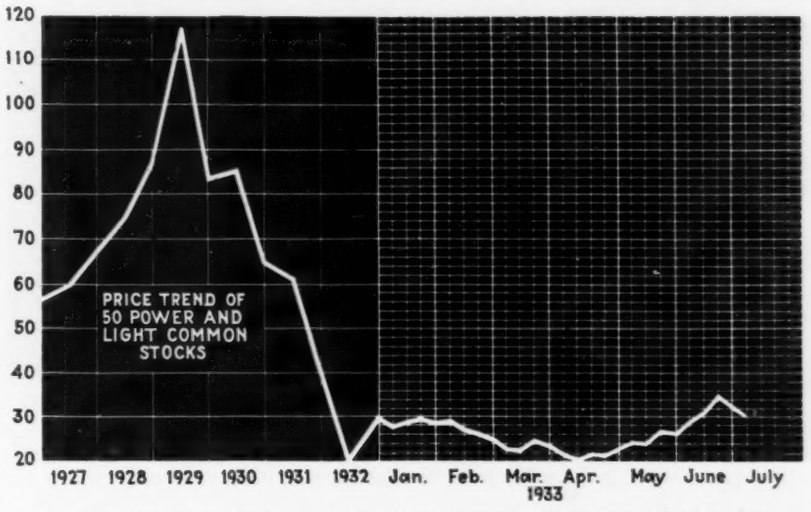
Further evidence brought out that the Long Island Lighting Company paid $65,000 for its Glen Cove plant on September 4, 1924, but valued it in 1929 at $350,655 on a basis of reproduction cost.

The reproduction cost of a small grass plot at the Glenwood power plant, No. 2, seeded in 1904 at a cost of $4.02, was listed as $156 in 1930. The increase, it was explained, was caused by the fact that "what was grass seed in 1904 was sod in 1930."

"So $4.02 worth of grass seed purchased and sowed in 1904," Col. C. G. Blakeslee, counsel for the commission, protested to witnesses, "would produce $132 worth of sod in 1930, to which you propose to add $24 as contractor's profit. Of course, the cost of watering and mowing would be charged to operating cost and charged to the consumer."

The hearings are being continued.

Stocks Weaken Further; Bonds Up



Paradoxically enough, in a situation brought about by inflation fear, utility stocks show a continuation of a weaker tendency, while bonds continue strong. Stocks, 30.9; last week, 32.7. Bonds, 91.4; last month, 90.2.

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Output Close to 1931 Rate

Central-station energy output rose another 1.4 per cent in the week ended June 24 to a total of 1,598,136,000 kw.-hr., according to the Edison Electric Institute. The excess over the corresponding output in 1932 has been increasing at an average rate of 1.5 per cent each week since early May and is now 10.9 per cent. The level of 1931 is being rapidly approached, the disparity having been cut to 2 per cent. Since mid-March 223,000,000 kw.-hr. has been added to the weekly output.

Regional comparisons give New England the extraordinary gain of 19.2 per cent over 1932, with the Central and Southern areas up nearly 14 per cent.

Weekly Output, Millions of Kw.-Hr.

Week ended	1933	1932	1931	1930
June 24	1,598	1,441	1,635	1,704
June 17	1,578	1,442	1,610	1,698
June 10	1,542	1,435	1,621	1,707
June 3	1,461	1,381	1,594	1,657
May 27	1,494	1,425	1,602	1,660

Per Cent Change from Previous Year

Region	Week Ended June 24	June 17	June 10
New England	+19.2	+18.2	+14.5
Middle Atlantic	+ 8.9	+ 7.0	+ 7.2
Central industrial	+13.9	+11.9	+10.0
Southern States	+13.8	+13.6	+10.9
Pacific Coast	— 0.6	— 1.4	— 5.3
United States	+10.9	+ 9.5	+ 7.4

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Output Up 32 per Cent on One Large System

Recent rapid gains in aggregate weekly output of energy merely sum up what has been going on in the various individual companies. Some of these are picking up their loads, compared with 1932, at a rate far faster than the nation-wide average. For example, the properties of the American Water Works & Electric Company have been running more than 30 per cent higher in output than at this time last year and have caught up with their operations in 1930, as is evident from the following table giving output in thousands of kw.-hr.:

Week Ended	1933	1932	1931	1930
May 27	32,274	26,164	31,689	36,597
June 3	31,356	24,932	32,861	33,930
June 10	33,480	25,768	32,751	34,686
June 17	34,638	26,230	32,116	34,785

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P.C.E.A. Elects Officers

Pacific Coast Electrical Association has elected the following officers for the coming year: President, W. C. Mullendore, Southern California Edison Company, Ltd.; vice-presidents, A. H. Markwart, Pacific Gas & Electric Company, and F. O. Dolson, Southern Sierras Power Company. Norman H. Sutherland, Pacific Gas & Electric Company, treasurer of the association, was re-elected. Amendments to the constitution officially severed connection between the association from the now-defunct National Electric Light Association.

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Los Angeles Calls for Bids on Boulder Dam Line Towers

Los Angeles municipal bureau of power and light has called for bids for the manufacture of structural steel for towers to carry the high-voltage transmission line that will connect the city's electric system with the federal hydro-electric project at Boulder Dam. Bids will be opened July 14.

At least 2,804 towers from 65 to 90 ft. high, involving 28,000 tons of structural steel, wll be used. Of this number, 2,533 will be single circuit and 271 double circuit. Over the 210 miles of desert country from Cajon Pass to the dam site the towers will be spaced 1,000 ft. apart. These will be of the single-circuit type.

From Cajon Pass to Los Angeles, a distance of approxmately 60 miles, the double-circuit type of tower will be used, spaced about 800 ft. apart.

Orders for the copper conductors to be installed on this line were placed several weeks ago (ELECTRICAL WORLD, June 17, page 777).

▼

Pacific Coast Hydro Is 64 per Cent of Total

Most recent data upon hydro-electric resources of the United States show 64 per cent of them to be upon the Pacific slope. J. T. Johnston, director of Canada's water-power and hydrometric bureau, presented a symposium at the fifth Pacific Science Congress, Vancouver, B. C., recently, which developed this and other interesting facts.

The Pacific drainage slope reaches a maximum width of 900 miles in the United States, diminishes to 50 miles in Central America, and throughout South America approximates 100 miles, said Mr. Johnston. Precipitation varies from extremes of 150 to 200 in. per annum, encountered at places along the Alaska and British Columbia coasts, to light rainfall in southern California and in the arid or semi-arid regions of southern Peru and northern Chile.

26,600,000 kw. for United States on Pacific Slope?

The United States, one-third of whose territory is tributary to the Pacific, has water-power resources on her Pacific slope estimated at 26,600,000 kw. continuous, or minimum flow, power and 40,700,000 kw. at six-month flow, or for 50 per cent of the time, Mr. Johnston stated.

In Alaska there are believed to be very considerable water-power resources, although no comprehensive investigation has been made. The capacity of waterwheels installed in the Pacific drainage area of the United States at the beginning of this year was 3,493,000 kw.

Canada's Pacific slope water powers are principally in the province of British Columbia, though the resources in the Yukon Territory are known to be considerable, but have not been investigated in any detail.

British Columbia has water-power resources placed at 1,800,000 kw. for ordinary minimum flow and 4,760,000 kw. ordinarily available for six months of the year, while the capacity of waterwheels installed at January 1, 1933, was 532,000 kw.

The full opportunities for development are not reflected in the figures, which are based on unregulated flow of the rivers and take no account of numerous natural sites in British Columbia for storage reservoirs, nor of the opportunities that exist for diversion of the flow of streams between watersheds.

Alabama Move Opposed in Muscle Shoals Power

Cities clamoring for municipal plants will have no guarantee of uninterrupted electric service even if they hook up with Muscle Shoals, J. M. Barry, general manager of the Alabama Power Company, explained in a defense of the company's rate structure before the Alabama state Utility Commission last week.

"I have heard a good deal about communities hooking up with Muscle Shoals and operating their own plants," said Mr. Barry, "and that is an entirely feasible plan. But they must keep in mind that to deal with important loads and important areas they cannot hang those loads on a single basis, for we have learned that cannot be done without total interruption of service in times of storms and from other causes."

Mr. Barry pointed out that the company had established two or more transmission lines into the main cities and that the number of total interruptions in service had shown a sharp drop in recent years. In Birmingham between 1924 and 1928 there was an average of eleven total interruptions annually, he said, while now there are 0.4 annual interruptions. In Montgomery there were fifteen total interruptions in 1924, and since 1931 there have been none.

Thomas W. Martin, president, in testimony before the commission, said the company spends on an average of $13,000,000 in the state annually in operating expenses and should be allowed an 8 per cent return on its investment as fair under present conditions.

At the instance of the company C. S. Reed, New York rate expert, told the commission that removal of the room charge would work a hardship on 70 per cent of the utility's consumers, particularly the small customers.

Ice manufacturers offered testimony to the effect that they were "dying" from high power rates and unless some adjustment was made there was no chance for the industry to exist. Cotton ginners also claimed high rates are driving them from business. Dairymen contended that electric rates should come down, since their income had dropped nearly 75 per cent.

The commission took the case under advisement.

▼

Would Trade Real Estate for Muscle Shoals Energy

Proposal of the Swann Corporation, Birmingham, Ala., chemical manufacturer, to build and operate a giant chemical plant at Muscle Shoals has been disclosed by Arthur E. Morgan, president of the Tennessee Valley Authority. The corporation offers to trade a series of undeveloped power sites on two East Tennessee rivers for power delivered at a plant to be built on the government reservation at Muscle Shoals.

Theodore Swann of Birmingham, president of the company, places a value of $1,300,000 on the power sites on the Nolichuchky and Hiwassee rivers in southeastern Tennessee. He has proposed to let the government have title to these sites, payment to be made in current delivered at the proposed plant at the regular industrial rates set for other customers. Under this proposal the Swann Corporation would lease a 70-acre factory site on the shoals reservation.

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Tennessee Authority Organizes for Action

Preliminary organization of the Tennessee Valley Authority, under the chairmanship of Arthur E. Morgan, is proceeding along definite lines. The three commissioners appointed by President Roosevelt will assume the following duties: Chairman Morgan, general manager; David E. Lilienthal, in charge of all legal matters; Harcourt A. Morgan, co-ordinator of industry and manufacture.

The temporary offices established in the Interior Department Building, Washington, will continue to receive and handle all applications for jobs pending establishment of permanent offices in the Tennessee Valley area. Chairman Morgan has made it known that the Washington office personnel will not greatly exceed 35 persons in addition to those taken over with the Fixed Nitrogen Research Laboratory at American University.

While there will probably be 1,000 opportunities for jobs on the Cove Creek dam project, Mr. Morgan implied that there is enough labor in the immediate locality of the dam to supply the total needs. Other projects which will offer employment are still on paper, but the authority expects to get to them as soon as possible. It is the policy of the authority, in developing the Tennessee basin, to take care of local unemployed so far as possible. However, all applications are receiving careful and individual attention.

The authority has $50,000,000 of President Roosevelt's $3,300,000,000 reconstruction fund at its command, with possibilities of additional income through the sale of power, fertilizer, etc. The first major project to be taken up will be the construction of the Cove Creek dam and reservoir. The total cost of this undertaking is estimated at $34,000,000. This will be spread over a four-year period.

Chairman Morgan estimates that it will be at least six months before actual construction work will begin at Cove Creek.

Major New Construction This Week

Machine drives, hoists, heavy-duty motors, transformers and auxiliary power substation equipment and other equipment will be installed at new Houston, Tex., drydock and ship repair plant of the Todd Shipyards Corporation. A $1,100,000 project.

Bend, Ore., is arranging financing for new city-owned electric light and power plant, estimated to cost $600,000.

Brooklyn (N. Y.) Bottling & Distributing Company, Inc., will add to present plant at cost of $350,000.

Tulsa Brewing Company, Tulsa, Okla., plans brewery with power house at cost of $450,000.

Electric generating equipment, transformers, accessories, pumping machinery, motors, conveyors, etc., will be required for Corpus Christi, Tex., plant of Southern Alkali Corporation. Cost over $5,000,000.

Berghoff Brewing Company, Fort Wayne, Ind., will double capacity at cost of over $200,000.

Motors, controls, conveyors, etc., will be installed in addition to mill of McEwen Knitting Company, Burlington, N. C. Cost about $100,000.

Oklahoma Brewing Company, Oklahoma City, Okla., plans brewery to cost about $350,000.

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British Energy Output Sweeps Sharply Upward

Official reports to the British Electricity Commission show that 1,004,000,000 kw.-hr. has been generated in May, as compared with 895,000,000 kw.-hr. in the same month last year. The percentage increase is 12.2 per cent. Less than one-half of the improvement may be accounted for through the incidence of one holiday and one more Sunday in May last year than in this.

In the first five months of 1933 5,603,000,000 kw.-hr. was generated, against 5,269,000,000 in the corresponding period of 1932, the increase being 6.3 per cent.

All the towers for carrying the transmission lines of the grid, which traverse approximately 4,000 miles, have been erected except for about 12 miles under construction and about 120 miles of secondary lines temporarily postponed.

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New York Metal Prices

	June 20, 1933 Cents per Pound	June 27, 1933 Cents per Pound
Copper, electrolytic	8.00	8.00
Lead, Am. S. & R. price	4.20	4.20
Antimony	6.50	6.50
Nickel ingot	35.00	35.00
Zinc, spot	4.65	4.70
Tin, Straits	44.625	45.37
Aluminum, 99 per cent	23.30	23.30

As to Rates——

• Commercial power rate reductions which will benefit about 1,100 customers of the Ohio Edison Company have been negotiated for Youngstown, Ohio, after months of agitation and several weeks of negotiation. A request by the Mayor that the residential schedules be likewise cut has been deferred. Ohio Edison reduced residential rates voluntarily last December, though its franchise specifying higher levels has nearly four years still to run.

• Characterizing as a "fraud and attempt to deceive" the rates recently instituted by the Philadelphia Electric Company, complainants told the Pennsylvania Public Service Commission at hearings last week that the elimination of the lamp-replacement feature of the previous schedule represented an increase in rates and that the $1,800,000 advertised reduction was not sufficient to offset this factor, let alone provide any real savings. An injunction is asked against the application of the new schedules.

• Governor Lehman of New York, unmoved by the pleas of a Queens County grand jury that a special session of the Legislature be called to settle the energy rate problem (ELECTRICAL WORLD, June 24, page 816), has informed the petitioners that an investigation is now going on under the auspices of the state Public Service Commission and that he proposes to await its outcome before proceeding further.

• Contending that "the petitioners have not proved by reason of this contract their cost of service has been increased and the public injuriously affected," Commissioner Webber of the Massachusetts Department of Public Utilities has defended the special rate afforded the New England Rayon Company by the New Bedford Gas & Edison Light Company. Petitioners sought to have the rate set aside on the grounds that the utility was selling energy at less than cost.

• Though the New Jersey House of Assembly passed resolutions directing the state Public Utility Commission to revise and lower the rates of public utilities in New Jersey, no action was taken to provide the special appropriation of $100,000 to finance an investigation before the state Legislature adjourned.

• Seeking to have rates revised in the territory served, a demand has been filed with the state Public Service Commission that the Western New York Gas & Electric Corporation and the Associated Gas & Electric system make separate reports of their earnings and rate structures.

• Electric rate reductions have been voted for Greenfield, Ind., by the Common Council. A cut of 48 per cent has been arranged in the municipal plant schedules, which carry a 75-cent-a-month minimum charge and range from 7 down to 3 cents a kilowatt-hour. No bonds or debts stand against the municipal plant and revenues contribute to the city general fund. The light department this year refunded to the city its payments for street lighting services.

State-wide move in Indiana?

• Petition has been filed by Sherman Minton, public counselor for the Indiana Public Service Commission, to require the Public Service Company of Indiana to show cause why its rates should not be reduced. Members of the state commission are thereby faced with an entirely new situation, and are in some doubt as how to proceed, since the petition is the first of its kind. If approved, the utility would be required to defend its present rate structure throughout its "south system," which serves more than 250 cities, towns and communities. The petition marks also the opening step in what was said by Gov. Paul V. McNutt to be a statewide program to reduce utility rates. The petition charges that the utility property last year earned about $2,000,000 "excess earnings," and that its income was about $4,600,000, including the excess as alleged. A fair return of 5½ per cent, the petition charges, is sufficient to constitute a fair return under present economic conditions. Utility officials say that the public counselor's figures relating to its condition are incorrect, and that his estimate of its value, "not in excess of $40,000,000," is too low.

• Department of Public Works, Washington State, proceeding on its own motion, has filed three additional complaints in its general investigation of power and water rates. Two charge retail and wholesale rates of companies operating in Grays Harbor and Pacific Counties to be excessive. In both cases the department will make valuation investigations, with hearings to be set later. The third complaint filed by the department involves retail water rates of the Panhandle Lumber Company and the Ione Water & Light Company, furnishing water for domestic purposes to Ione and vicinity in Pend O'Reille County.

• Counter-attack to the public agitation for lower electric rates has been launched by the Alabama Power Company in a series of newspaper advertisements. Facsimiles of newspaper headlines are reproduced showing that the tendency of farm prices and everything else except electricity is up instead of down. Figures are quoted to show that average electric rates for home service in Alabama are 57.4 per cent lower than they were in 1913 and 14 per cent below the national average. "The only inflation in electric service is in its greater usefulness," says one of the advertisements.

• Under the provisions of a temporary schedule the Birmingham Electric Company offers to furnish electric power for industrial consumption during the summer based on actual consumption and to disregard the existing rate schedule during that period. This is done, it is said, as a means of aiding a number of industrial plants in Birmingham to operate on small orders on hand, but which are not sufficient to justify the incurring of the obligation for power that would arise should they start operations under the existing power schedule. The "rider" to the industrial power schedule provides that billings for power consumption during this period shall be based on actual meter readings, during which the regular schedule will be held in abeyance.

Missouri has new plan

• It has been suggested by John C. Collet of the Missouri Public Service Commission that expensive and long drawn out audits and appraisals of utility properties be dispensed with and an entirely new procedure put into effect to determine the fairness of rates.

Instead of commission accountants and engineers spending months, and in the cases of larger utilities, years, in appraisals and audits, the commission would order such work done by the utilities themselves and presented to the commission under oath.

Any reductions brought about by such a step, in the opinion of members of the commission, would be upheld by the courts, since the utilities would be unable to go behind their own sworn statements.

Formal announcement of the plan is expected this month.

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Receiver for Continental Shares

Cyrus S. Eaton's ill-fated Continental Shares, Inc., venture, following the auctions of its securities pledged against bank loans (ELECTRICAL WORLD, June 17, page 780, and June 24, page 809) passed into receivership late last week.

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Washington Municipals Protest

Unwilling to accept the excise tax imposed upon municipal or privately owned public utilities, representatives of ten of the larger municipalities of Washington State met several weeks ago to devise ways and means for presenting a united front to contest the constitutionality of the tax.

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New Power Sales Organization

Power sales engineers affiliated with New England utilities and formerly allied with the N.E.L.A. geographic division under the name of the New England Association of Central Station Power Engineers and Power Bureau of the then national body organized the Power Engineers Association at a meet-

ing in Marblehead, Mass., recently for the purpose of interchanging experience and data and furthering industrial central station service. Dale M. Washburn of the Boston Edison Company was elected chairman, H. H. Carpenter of the Blackstone Valley Gas & Electric Company, Pawtucket, R. I., vice-chairman, and J. E. Spike of the Cambridge Electric Light Company secretary-treasurer. The schedule calls for meetings about six weeks apart throughout the year.

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Municipals and Muscle Shoals

Plans to secure the co-ordinated application of some 100 Mississippi cities for the right to distribute Muscle Shoals power were launched last week with the formation of the Northeast Mississippi Municipal Association.

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Washer Sales Increasing

That household washing machine sales are increasing steadily throughout the country is the conclusion of J. R. Bohnen of the American Washing Machine Manufacturers' Association from the production record of the industry. Sales for May totaled 62,963 units, an increase for the fifth consecutive month and the industry's largest month, with one exception, since April, 1931. The May record was 8,779 washers above April, 1933, and 25,999 machines ahead of May, 1932.

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22,500-hp. Engine for Denmark

What is said to be the largest single oil engine yet built has been completed and is now undergoing trial runs at the Oersted station in Copenhagen, Denmark. It is a 22,500-hp., two-stroke, double-acting unit.

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Canadian Hydro Survey

Foreseeing hydro-electric power development on the upper Rimouski River, and realizing that this would involve a storage reservoir in the valley half way between the boundary of New Brunswick and Quebec and the St. Lawrence River, engineers of the Quebec Streams Commission will survey the district to determine just what land is to be reserved for creation of an artificial lake at the head of the river.

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Japanese Tidal Plan

By diverting water now flowing into the Yellow Sea to discharge into the Japanese Sea nearly 1,750,000 kw. can be added to the hydro-electric resources of Korea, according to Dr. M. Shibusawa of the Tokyo Imperial University. Actual development in Korea now totals 165,644 kw.

Electrical Exports Rise

Exports of electrical machinery and apparatus in May, as compiled by the Bureau of Foreign and Domestic Commerce, showed a marked increase over the value of exports in April. Figures for electrical machinery were, May, 1933, $3,109,410; April, 1933, $2,877,083, and May, 1932, $3,771,051.

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California Contractors Organize

Organizing to take advantage of the opportunity to improve business practices and methods in the contracting business, two major bodies of contractors in California are taking steps to form associations to comply with the provisions of the national recovery act. The Electrical Contractors Association of Northern California has completed a series of meetings in the northern part of the state. About 300 electrical contractors responded to a meeting called by the Southern California Electrical Contractors and organized the Electrical Contractors and Dealers Association of Southern California. Details of the method of operation will be worked out by the existing executive committee.

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Fixture Wages Increased

Members of the wholesale lighting fixture manufacturers division of the Lighting Fixture Merchants Association unanimously voted to increase wages 10 per cent at a meeting last week when an industry code was adopted. Said to affect 25,000 workers, the increase is to be made effective at once. Piracy of designs, sales practices and similar matters are covered in the code.

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Belden Wins Wire Litigation

In settlement of the suit for wrongful possession and use of trade secrets pertaining to the manufacture of enameled wire, instituted by the Belden Mfg. Company against the Strand & Sweet Mfg. Company, several years ago acquired by Polymet Mfg. Company, bankrupt, the trustee for the latter has surrendered to Belden 90 enameled wire machines originally valued at $67,500, alleged to have been constructed and used in violation of that organization's trade secrets.

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New British Station Planned

Construction has begun, in England, upon a new generating plant on the Thames River to be known as the Fulham station. As a first step there will be installed two 60,000-kw. main turbogenerators and one 10,000-kw. house turbine. Steam conditions will be 625 lb. per square inch and 850 deg. F. Each alternator will be tied directly to the main 11/66-kv. transformers and paralleled on the 66-kv. side. Metal-clad switchgear is to be used.

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Morgan Registers Assets

Mindful of the charges which have arisen to plague others in the public service and apparently determined to set the stage thoroughly in accordance with the facts, Arthur E. Morgan, head of the Tennessee Valley Authority, has addressed the Secretary of State as follows:

"As a matter of public policy I am sending you herewith for your record a statement of all real and personal property and other assets owned by me, and by my wife and children, as of June 1, 1933. I suggest that this be filed with my oath of office. A copy is being sent to the Attorney-General. It is my intention to file a comparable statement when I relinquish the above-mentioned office."

Brief History of the "Electrical World"

The *Electrical World* (published under that name since 1883 and tracing its history back to 1874) is a consolidation of the *Electrical Engineer* (founded in 1882 as the *Electrician*) and the *American Electrician* (founded in 1896). Final consolidation under the title of *Electrical World* took effect on January 1, 1906, the *Electrical World* and the *Electrical Engineer* having been acquired by the McGraw Publishing Company in 1899 and amalagamated as the *Electrical World and Engineer*, and the *American Electrician*, a McGraw monthly, having been absorbed seven years later.

The roster of past editors of the *Electrical World* includes Carl Hering, Louis Bell, W. D. Weaver, T. C. Martin, C. O. Mailloux, D. H. Braymer and many other men prominent in the electrical industry—some, like those named, no longer living, and others, like W. H. Onken, Jr., A. S. McAllister, Frank F. Fowle, F. M. Feiker, and H. V. Bozell, still active in engineering and industrial service. L. W. W. Morrow is now editor. Allen M. Perry is managing editor. Other members of the present staff are: A. E. Knowlton, associate editor; E. R. Searles, news editor; G. F. Wittig, statistical editor; F. R. Innes, Western editor; C. W. Leihy, Pacific Coast editor; E. M. Glennon, assistant editor; H. S. Knowlton and Earl Whitehorne, contributing editors; and Paul Wooton, Washington correspondent.

EDITORIALS

L.W.W.MORROW
Editor

There is no surplus capacity

DURING this depression 30,000,000 kw. of electrical appliances and electrical industrial equipment has been sold. This connected load is on the lines and represents about a 14 per cent increase. During the same period only 3,500,000 kw. of generating capacity has been added. The only reason the utility industry is able to serve the new load is because of the 30 per cent decrease in the large industrial power load. The new increment load held up the industry to a decrease in the total energy sold of 15 per cent only, contrasted to the general business drop of 40 per cent.

Now the scene is changed. Several properties report an all-time peak load and output in May. The national output is increasing rapidly and is now within 7 or 8 per cent of the 1929 or 1930 peak conditions. If the present business up-turn continues the old industrial load will be added to the load sold during the depression to create new records and new demands for facilities. There will be a lack of utility capacity to serve the loads and not a surplus.

It takes at least a year to add new generating capacity and the loads are increasing at a very rapid rate. Therefore there is no reason for utility executives to say, as some did at the Edison Electric Institute convention, that the industry will not need to build or expand for years. On the contrary, there is every reason for them to look at the facts and to call in their engineers and construction forces to plan to meet record-breaking service needs. The service must be rendered and the necessary facilities must be installed. It is apparent that if the present up-turn continues the utilities will not be able to meet the demand without extraordinary effort. Now is the time to get busy on plans for increased capacity. It is not the time to talk about surplus capacity.

Shall we quit inchin' along?

TO LISTEN to the speeches in Chicago a few weeks ago one would believe that the entire power industry was now concentrated on selling. With rates going down and taxes going up and little business coming from the factories today, everybody realizes the importance of building up domestic consumption and developing the lighting load. And everybody agreed that this should be done. But will it be done? And how much?

The greatest impediment to progress in the electrical industry lies in the fact that there is an old, hidebound tradition among executives against spending money to get business. A new transmission line? Certainly—appropriate a million dollars if it will bring system economies and amortize itself within a reasonable time. A new substation? Why, of course—another million here. It's good business. And authorize any extension that promises to pay back from new consumers in three years. Why not? Charge it to capital account. But ask for a million dollars to invest in selling lighting and appliances this fall and winter and see what happens. The sales manager who proposed it would be lucky to escape without frostbitten ears.

And so we go along slowly, gaining a little each year. We point with pride to an average annual residence consumption of 601 kw.-hr. and forget that it has taken us since 1926 to raise it up from 425. We rejoice, as in the old song, that we are "Inchin' along, Lawd! Inchin' along!" But when

we need a new transmission line or a new station we go get the money and build it—all of it. Why haven't we that kind of courage in load building?

The kind of selling the power industry needs right now is going to cost money. And it will be worth it. It will increase revenue. It will improve load factor. It will pay for itself in a few years, then continue. But it will require a major operation—a bold program, liberally financed, highly organized, to bring quick returns in a big way.

But nobody said that at the E.E.I. convention. They just talked about how important it was—how much the load is needed. But the important thing is to face the fact that to sell more electricity to 20,000,000 people is a big job. And the question is—shall we quit "inchin' along" and go after it?

Some people will be fooled

THOSE in touch with engineering, with research and with technological progress are amused, to say the least, at the complacency with which utility and industrial executives state that engineering and technological problems are not of major importance these days. They either do not know about the technological bombs that are ready to disrupt them or they refuse to become informed. In several instances engineers who sought to inform their executives of actual conditions have been thrown out of the executive office and even have been fired. Unpleasant news is unwelcome, yet what wisdom is there in neglecting facts or dismissing those whose duty it is to report facts?

In industry and in the utility field informed engineers do not hesitate to say that half the present plant is economically and technologically obsolete. New equipment, new processes, new assemblies are ready to go to work and will go to work because they are cheaper and better. There is no defense against the weapons of the engineer except to adopt them and to use them. A sudden and sad awakening is due the corporation executive who thinks the *status quo* in engineering has been reached. May we point out too that it is the small industry or the small manufacturer or the small utility that is apt to know about and use the engineer and his new contributions first and most effectively. These small units are now in the market. They have hired the majority of the engineering graduates of this year and have sought out and hired the able engineers dismissed by the large corporations. Just watch these engineers. They are going to tear down the old and rebuild a new physical plant for industry and for the utilities in the next ten years.

The unprofitable consumer expected to pay his way

FROM the decision of the Massachusetts commission in the Cambridge rate case it is evident that the board has been giving considerable thought to the cost of distribution. From the studies of Clayton W. Pike the commission worked out an average cost of overhead distribution of $1.20 per customer per month for Massachusetts and concluded that under present costs a customer who does not return this sum to the company, plus the cost of electricity at his nearest substation, is unprofitable. In modifying the domestic rate the board took this into account and refused to establish a flat charge of 2.5 cents per kilowatt-hour as urged by the petitioners for a reduction from 5 cents. It left the first block unchanged as regards the maximum rate, but fixed a limit of 75 kw.-hr. for this block instead of the present 2,000. The company has an optional area rate, which was left unchanged. To put all domestic customers on a plane comparable with those using the optional rate the board ordered a rate of 2.5 cents per kilowatt-hour above the 75 kw.-hr. limit.

The commission's recognition that a large number of residential customers are carried at a loss is supplemented by its refusal to cut the present rate before the consumption of energy has been sufficient to carry the consumer "out of the red" on the company's books. A political decision would not have worked out in this way. Without commenting upon the effect of the reduction on the company's earnings, it is gratifying to note that the unprofitable consumer will not be permitted to become a still heavier burden through premature and unjustified cuts of the rate under which he uses energy. The principle of "earning" a lower average rate by increase usage offers such customers a way out of their present estate with mutual benefit to them and to the company. The situation in Cambridge was aggravated by the absence of a minimum charge, but the economic influence of distribution costs in low consumptions is adverse on its own demerits.

Design Features of Milwaukee's New 1,200-Lb. Station

By G. G. POST*
Vice-President in Charge of Power
Milwaukee Electric Railway & Light Company

THE Port Washington generating station of the Milwaukee Electric Railway & Light Company, now under construction, is located on the west shore of Lake Michigan, 28 miles north of Milwaukee. The station's initial capacity will be 80,000 kw. (one unit) with a possible ultimate capacity of 400,000 kw. (five units). The outstanding feature will be its unit design; that is, there will be a single boiler for each single turbine-generator and also one set of transformers, one 132-kv. transmission line and one set of auxiliaries for each unit.

1,200-lb. steam cycle selected

Economy and reliability figures definitely established 1,200-lb. pressure as being far superior to 300 lb., 300-lb. pressure being used in this comparison because the equipment in the existing Lakeside plant, before installing the 1,200-lb. equipment, was built for it. But in order to exhaust all possible claims for intermediate pressures a comparison was made between 600 lb. and 1,200 lb. The results shown in Table I indicated that the 1,200-lb. cycle would save $36,754 annually over the 600-lb. cycle in the initial installation at Port Washington, after deductions had been made for fixed charges on the greater investment required.

Lakeside has a reputation for being a pioneering station in economically sound adventures. Thanks to a liberal company policy, marked by keen foresight, every opportunity has been given to improve the art of producing and distributing electrical energy. In planning Port Washington this same policy was continued. It was believed that progress should be made and that some improvements over Lakeside were possible. Among those considered was the possibility of going to a higher steam temperature. Superheater manufacturers, valve, pipe and also turbine makers were consulted. All expressed their willingness to co-operate and subsequently quoted prices on equipment necessary not only to produce 825 deg. F. at the turbine throttle and reheat point, but to maintain it continuously; 850 deg. F. was specified as the maximum. The increase of 75 deg. F. in actual operating temperature (Lakeside's is 750 deg. F.) brings the total steam temperature up to the point where ordinary steels cannot be used in the turbine. Alloys require greater investment, particularly in large turbines, where they had not been previously applied to the extent that they had been in steam superheating equipment and in valves. The net greater cost of 850 deg. F. equipment totaled $28,170 in investment. With fixed charges taken at 13 per cent, the annual rate amounted to $3,650. The fuel saving, on the other hand, amounted to $18,720 per year, resulting from a 2.5 per cent better station heat consumption rate. The net saving was, therefore, calculated to be $15,070 per year. The greater investment resulted from a more expensive turbine, greater cost of valves and fittings and greater cost of superheaters and reheaters. These greater costs were offset by investment savings in boiler plant equip-

**Excerpts from paper presented at A.I.E.E. annual convention, Chicago, June 26-30, 1933.*

Table I—Comparison of 1,200-Lb. Generation With 600-Lb. Generation

(Reheating to Same Temperature for Both Pressures)
Estimated for Port Washington

Economy		
1.	Estimated annual generation for initial installation 80,000 kw. at 60 per cent annual load factor, million kw.-hr.	421
2.	Saving in heat consumption by 1,200-lb. cycle over 600 lb. (average all loads), B.t.u. per kw.-hr.	856
3.	Annual B.t.u. saving in favor of 1,200 lb., 100 million B.t.u. per year	3,610
4.	Cost of fuel per 100 million B.t.u.	$14.82
5.	Total annual fuel saving, 1,200 lb. over 600 lb.	$ 53,500
Investments		
6.	Greater investment for 1,200-lb. boiler-room equipment	147,168
7.	Greater investment for 1,200-lb. turbine room	19,300
8.	Lesser investment for 1,200-lb. turbine-room equipment	20,000
9.	Lesser investment for 1,200-lb. station tunnels, circulating water system, and coal handling system	17,650
10.	Net greater investment for 1,200-lb. installation	128,818
11.	Annual fixed charges on greater 1,200-lb. investment at 13 per cent	16,746
Net Saving		
12.	Net annual saving of 1,200-lb. installation over 600-lb. installation of 80,000-kw. capacity	36,754

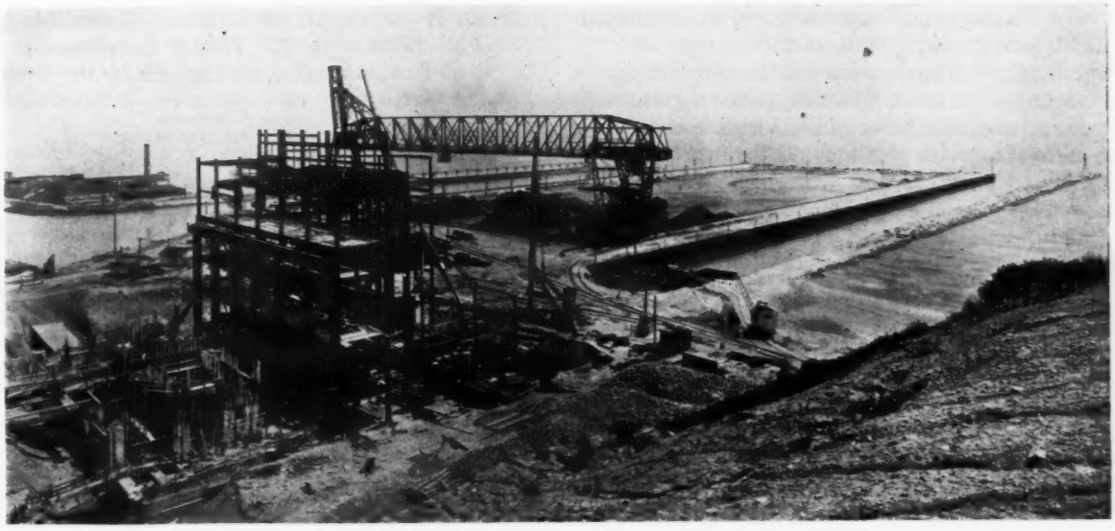
In comparing the economies of 1,200-lb. generation with 600 lb. a considerable saving in fuel was found. This, together with the unexcelled reliability record of Lakeside's 1,200-lb. equipment, decided the issue in favor of 1,200 lb.

Table II—Comparison of 825 Deg. F. and 750 Deg. F. Temperature at Both Throttle and Reheat

Estimated for Port Washington

Economy		
1.	Estimated annual generation for initial installation, 80,000 kw. at 60 per cent annual load factor, million kw.-hr.	421
2.	Saving in heat consumption, 825 deg. over 750 deg., B.t.u. per sw. bd. kw.-hr.	300
3.	Annual B.t.u. saving, 825 deg. over 750 deg., 100 million B.t.u.	1,263
4.	Cost of fuel per 100 million B.t.u.	$14.82
5.	Total annual fuel saving, 825 deg. over 750 deg.	$ 18,720
Investments		
6.	Investment saving of 825 deg. due to lower heat consumption, per cent	2.5
7.	Unit investment to which heat saving applies, dollars per kw.	47.30
8.	Total investment saving of 825 deg. = $47.30 times 80,000 times 2.5 per cent	$ 94,600
9.	Total investment saving assuming 75 per cent of total saved	71,000
10.	Additional investment saving in two steam drums, due to lesser storage required	5,670
11.	Additional investment saving due to deferring replacing last rows of blades because of lesser moisture in exhaust	10,920
12.	Total investment saving, 825 deg. over 750 deg.	87,590
13.	Greater investment cost of 825-deg. turbine	89,000
14.	Greater investment cost of 825-deg. valves and fittings	8,000
15.	Greater investment cost of 825-deg. superheater and reheater	18,760
16.	Total greater investment cost, 825 deg. over 750 deg.	115,760
17.	Net greater investment cost, 825 deg. over 750 deg. (item 16 minus item 12)	28,170
Net Saving		
18.	Annual fuel saving, 825 deg. over 750 deg.	18,720
19.	Annual fixed charges on greater investment at 13 per cent	3,650
20.	Net annual saving, 825 deg. over 750 deg.	15,070

An increase in operating temperature to 825 deg. F. from 750 deg. F. for both throttle and reheat showed a 2.5 per cent improvement in station performance. When the saving was capitalized on the basis of reducing equipment costs in the boiler room it offset the increased cost of the turbine, valves and fittings and showed a substantial net saving for the higher temperature.



Port Washington generating station June 8, 1933

Boiler room steel about ready to have the boiler drums swung into place; turbine room foundations at the left. Coal dock, with 10-ton bridge having a span of 422 ft. between rails, shown in the background. The bluff on the site of the plant was removed and used for dock fill.

ment due to the smaller amount of steam required, less water storage required in steam drums and by deferred expenditure for replacing the last row of turbine blades due to less moisture in the exhaust steam (see Table II).

One turbine, one generator and one boiler

A previous study had shown that one large turbine-generator would save $7.15 per kilowatt over two half-size units in investment costs (turbine-generators, foundations, turbine room building, electrical equipment and switch house) and about $25,000 per year in operating costs due to a better rate of heat consumption. These savings were considered sufficient to warrant the installation of an 80,000-kw. unit rather than two 40,000-kw. units. Incidentally, an 80,000-kw. machine would match almost exactly the 90,000-kva. transmission lines which had been adopted for the Milwaukee district.

After having established the size and type of the turbine to be installed, the next consideration was the number, size and type of boilers. Detailed comparisons were made on the installation of two boilers of small size (345,000 lb. per hour capacity) and of one boiler of large size (690,000 lb. per hour capacity).

One boiler was selected rather than two because:

1. An investment saving of approximately $250,000 could be made.
2. The operation would be simpler due to not having to apportion the exhaust steam from the high-pressure section of the turbine to each of the two reheaters.
3. The presence of an 80,000-kw. turbine-generator on the system would require 80,000-kw reserve in any event. Therefore, no additional losses in capacity would occur due to boiler outage.

At Lakeside three-drum bent-tube type boilers with comparatively large low-heat release furnaces had unprecedented reliability records. Certainly records of this nature could not be ignored in making selections for the Port Washington boilers.

It was true that a small saving in investment was shown with the straight-tube boiler layout over that of the bent-tube type, but this saving was more than offset by operating losses. Table III summarizes these gains and losses. Then, too, high-pressure economizers (1,600 lb.), which are an essential part of the straight-tube boiler layout, were considered a potential source of trouble. As explained later, economizers were eliminated entirely from the Port Washington design.

It was concluded finally to adopt the bent-tube type boiler fired from one side only with a low-heat release hopper-bottom furnace beneath it. Besides the economic gains and the possibility of eliminating economizers, the following additional reasons influenced its selection:

1. About 50 per cent more water-storage space is available, which is very important when only a few minutes total storage is available.
2. Tubes, being nearly vertical, permit rapid water circulation, which eliminates wide variations in drumwater levels throughout the load range.
3. Dry steam is obtained since the rear drum acts as a dry drum, it having little steam released from the water it contains.
4. Water-wall connections can easily be made because of accessibility of the drums.
5. Suspended solids in the boiler water are removed effectively in the lower drum.

Radiant superheater and reheater

Radiant superheater and reheater surfaces for side and rear walls and water tubes for the front wall and the ash screen were the final answer to the furnace prob-

Table III—Comparison of Boiler Designs for Port Washington—Initial Installation

	Bent-Tube Boiler Low-Heat Release Furnace	Straight-Tube Boiler High-Heat Release Furnace
1. Total investments in boiler, furnace, superheater, reheater, economizer, air-heater feeders, burners, and milling equipment*	$937,137	$838,805
2. Greater investment of bent-tube boiler	98,332	
3. Greater annual fixed charges at 13 per cent	12,783	
4. Increased operating costs		
a. Greater pressure drop in superheater		$156
b. Greater pressure drop in reheater		1,920
c. Loss of heat in molten ash		1,780
d. Lower over-all boiler efficiency		6,370
e. Poorer availability		3,900
f. Lower reheat temperature		2,720
g. Greater furnace maintenance cost		5,700
h. Total greater operating cost		$22,546
5. Net annual saving of bent-tube boiler with low-heat release furnace	$9,763	

The bent-tube boiler with a low-heat release furnace not only will produce an annual saving of $9,763 but will also permit the use of radiant superheat and reheat surfaces within the furnace and afford other operating advantages.

*Building not included because costs would be identical.

lem after all advantages and disadvantages of other combinations had been carefully balanced.

The superheater selected has a radiant section and a convection section. The steam will pass first through the former and then the latter. With this combination the steam temperature to the turbine throttle will vary only from 830 deg. F. at full load to 802 at quarter load. The reheater, on the other hand, is radiant entirely and its outlet temperature will vary from 834 at full load to 827 at quarter load.

A comparison between four extraction heaters plus an economizer-air heater combination and five extraction heaters plus an air heater only indicated that a net annual saving of $7,429 could be made through the use of the latter. The major portion of this saving is effected by the 1.3 per cent better heat rate of the turbine due to the fifth heater. Although the addition of an economizer would reduce the flue gas temperature 25 deg. F. and thus make a substantial saving in boiler efficiency, the fixed charges on the greater investment for the economizer and piping (after taking credit for the smaller air heater) and the maintenance costs on the economizer would more than offset this gain. Five-stage heating with an air heater but with no economizer was therefore decided upon.

Bin and feeder preferred for fuel

Boiler efficiency obtainable with the unit system was about equal to that of the bin and feeder system, with no gain for either on such items as carbon loss, uniform grinding, etc. There were, however, inherent advantages of the bin and feeder system which influence total station economy rather than only boiler efficiency and it was these which decided the matter in its favor. The most outstanding of these advantages are:

1. Greater reliability. With the unit system any outage of a mill for any reason will cause a reduction in capacity of the boiler or complete outage of the boiler. Whenever a reduction in load occurs it must be picked up by some standby or less efficient station, and a loss of 0.1 per cent in economy might result.

2. Flexibility. The low rating limitation of the unit mill is absent entirely from the bin system. This is particularly important at times of starting when low furnace temperatures are desired to prevent damaging superheater tubes.

3. Mill drying with flue gas can be used in the storage system to advantage, while, on the other hand, it cannot be used efficiently in the unit system. Venting flue gases back into the furnace is not conducive to efficient combustion and to the maintaining of proper flame control. With flue gas drying in a storage mill 6 per cent of the total flue gas discharges to the stacks at a temperature 200 deg. F. lower than the usual exit temperature. In addition, air heater performance is improved due to the greater mean temperature difference and the greater heat absorption in the air heater. After the flue gas mill drying system has been charged with the small coal vent loss, it shows a net gain of 0.5 per cent over using hot air and venting to the furnace.

4. Coal feed can be regulated more closely with the storage system, resulting in the maintenance of high average CO_2 and fine control of excess air. With radiant superheaters and reheaters this is important. Coal feed variations of 10 per cent, as is common with the unit system without hand adjustment, can cause a 50 deg. variation in reheat temperature and 0.6 per cent decrease in station economy.

5. Coal feed control at Lakeside, where the storage system is used, has been found to be so regular that boiler pressure can be regulated to within 5 lb. of a standard. With the unit system the pressure variations might be on the order of 50 lb. The difference of 45 lb. in pressure at the turbine could cause 0.6 per cent difference in economy.

6. When using air drying with unit mills the heated air to the mill must be tempered with room air. This reduces the amount of air to be taken through the air heater and reduces the boiler efficiency about 0.3 per cent below that of a storage system boiler.

Table IV—Comparison Between 4 Extraction Heaters Plus Economizer-Air Heater Combination and 5 Extraction Heaters Plus Air Heater Only

Four Extraction Heaters Plus Air-Heater Only Is Used as the Basis for This Comparison

Estimated for Port Washington

	Gain	Loss
Four-Stage Heating and Economizer		
1. Saving due to lowering of flue gas by 25 deg. F.	$4,520	
2. Maintenance cost on economizer		$2,000
3. Pumping cost for pressure drop through economizer		120
4. Fixed charges on greater investment cost for economizer and piping after deducting credit for smaller air heater, $35,800 at 13 per cent		4,654
5. Total costs	$4,520	$6,774
6. Net annual loss for economizer		2,254
Five-Stage Heating		
7. Better heat consumption rate due to fifth-stage heaters—112 B.t.u. per kw.-hr.	$6,995	
8. Maintenance cost on fifth-stage heaters		400
9. Pumping cost for pressure drop through heaters		120
10. Fixed charges on investment in fifth-stage heaters, also necessary piping, $10,015 at 13 per cent		1,300
11. Total costs	$6,995	$1,820
12. Net annual gain for fifth-stage extraction heaters	5,175	
Net Comparison		
13. Net gain to fifth-stage heaters	$5,175	
14. Net loss due to economizer	2,254	
15. Net annual difference in favor of fifth-stage heaters	$7,429	

Economizers ordinarily are thought of as equipment used to enhance power plant operating efficiency. This tabulation shows that extraction heaters do this more effectively and with far less need for worry about operating difficulties under the higher pressures encountered.

Table V—Comparison of Storage System and Unit System of Pulverized Fuel Firing

Estimated for Port Washington

Economy	
1. Estimated annual generation for initial installation, 80,000 kw. at 60 per cent annual load factor, million kw.-hr.	421
2. Saving in heat consumption, storage over unit, per cent	2.1
3. B.t.u. saving, storage over unit, B.t.u. per kw.-hr.	252
4. Annual B.t.u. saving, storage over unit, 100 million per year	1,061
5. Cost of fuel per 100 million B.t.u.	$14.82
6. Total annual fuel saving, storage over unit	$ 15,750
Labor, Maintenance and Power	
7. Greater cost of labor (1 extra man) storage over unit	2,400
8. Greater cost of maintenance, storage over unit	950
9. Lesser cost of power, storage over unit	575
10. Net greater operating costs, storage over unit	2,775
Investments	
11. Greater investment cost in mills, feeders, burners, motors, starters, duct work, foundations, air compressors, fuel bins, etc., storage over unit	59,112
12. Greater annual fixed charges at 13 per cent, storage over unit	7,685
Station Peak Capacity	
13. Greater kilowatt demand of unit system motors at time of station peak	592
14. Value of 592-kw. station capacity at $75 per kilowatt	44,400
15. Lesser annual fixed charges on station capacity, storage over unit	5,772
Net Saving	
16. Net annual saving, storage system over unit system (item 6 minus item 10 minus item 12 plus item 15) =	11,062

The battle of storage *vs.* unit system of pulverized fuel firing was waged for many weeks in the Milwaukee Electric Railway & Light Company's engineering department before the storage system was awarded the decision. Its merits include not only an annual saving of $11,062, but greater reliability and flexibility, as well as safety, due to the possibility of using flue gas mill drying with it.

7. Automatic combustion control is much more positive on a storage-fired boiler than on a unit-fired one. With the latter difficulties are encountered in co-ordinating the mill speed, primary air volume and sizing of the pulverized coal particles with the requirements of the boiler. Lower over-all efficiencies will result.

These advantages, totaling 2.1 per cent in station economy, can be credited to the storage system. Investment costs were found to be 74 cents per kilowatt lower for the unit system. Labor, maintenance and power were slightly in favor of the unit system. An important point in favor of the storage system is that most of its motors can be shut down at the time of the station peak. The unit system, on the other hand, requires peak electrical demand for auxiliaries coincident with the peak station demand, and to provide the same margin in capacity an equivalent in generating capacity must be installed at the same station or elsewhere.

Another important advantage of the storage system

is the safety to personnel and equipment occasioned through the use of flue gas for mill drying. A 12 per cent volume of CO_2 (an inert gas) is maintained in the mill system and collectors; danger of fire or explosion from smoldering coal is lessened materially.

The analysis, of which Table V is a summary, showed the bin and feeder system to effect a net annual saving of $11,062, and this, together with certain operating advantages, formed the basis for its adoption.

Generation at 22,000 volts

In selecting the generator voltage the following were considered:

1. No pioneering in generator voltages was desired.
2. A voltage was desired that would enable industries which might locate in the vicinity of the plant to connect their lines to the busbars as economically as possible.
3. If any economies could be effected in the plant investment and operating costs by using a voltage higher than 13,800 (the Lakeside voltage) such economies should be realized.
4. It would be desirable to adopt a voltage which would permit the connection of the existing 26,400-volt secondary transmission lines of the company with a minimum of expense. This is not a matter of much importance because very little of the energy will be delivered at this voltage. Most of it will be stepped up directly to 132 kv.
5. A voltage was desired that all manufacturers would be willing to use in their machines without resorting to special construction, such as concentric conductors.

The voltage which most nearly met all of these conditions was found to be 22,000. In using this voltage it was found that a saving of 0.3 per cent could be realized in investment and operating costs of generators and electrical equipment over similar costs for 13,800 volts. No saving could be effected by adopting 26,400 volts because equipment in the 34,500-volt class, which is more expensive, would then have been necessary. Because of the adoption of 22,000 volts it is necessary to use auto-transformers to connect to the lines operating at 26,400 volts.

22,000-volt indoor switching equipment

It was found that for the initial section the outdoor metal-clad equipment would require an expenditure of $6.03 per kilowatt, while the indoor vertical-isolated phase construction, including building and foundations, would require an expenditure of $5.62 per kilowatt, or $0.41 per kilowatt in favor of the indoor vertical-isolated phase arrangement. In the ultimate station, with relatively more switching equipment because of the duplication of switches on certain lines and the use of a ring 22,000-volt bus with reactors, the corresponding figures would be $7.62 per kilowatt for the outdoor metal-clad and $5.78 per kilowatt for the indoor vertical-isolated phase arrangement, including building, a saving in favor of the indoor arrangement of $1.84 per kilowatt. In view of the economies that could be effected and other advantages, such as the greater ease of making changes from the original layout and the use of oil-less circuit breakers in the indoor arrangement, it was decided to put all of the 22,000-volt switching equipment indoors. After deciding upon the use of indoor equipment, it was thought desirable to consider the merits of various kinds of indoor equipment and so cost figures were prepared on indoor three-pole assembly metal-inclosed equipment. It was found that in the initial installation the metal-inclosed equipment would cost $0.17 per kilowatt more than the vertical-isolated phase arrangement and $0.31 per kilowatt more in the ultimate installation. Vertical-isolated phase construction was therefore selected.

The only steam-driven auxiliaries in the plant will be one feedwater and one house-service pump.

▼

Welding Converts Steel Tonnage From Pouring to Rolling

"A large part of the tonnage now going into castings will be the product of our plate and structural mills. Yesterday we tried to visualize a 15 to 20 per cent conversion; today's indications are that 60 per cent is nearer the correct figure and developments in the near future will possibly again force us to revise our ideas . . . Commercial welderies are being established . . . Their business will no doubt replace to an appreciable extent that of commercial forge shops and foundries. They offer a potential business of several million tons of rolled steel products annually."

This bold prediction was made by H. G. Marsh of the Carnegie Steel Company in a paper presented at the May meeting of the American Iron and Steel Institute in New York. The paper emphasized the necessity of the welding designer clearing his mind of the restrictions imposed by cast construction. Replacing cast iron or cast steel with rolled steel, part for part, section for section, results in nothing gainful. The savings and the advantages are derived from a new start predicated on the function of and stresses imposed upon the welded assembly. It is also desirable for the designer to prescribe the welding procedure so completely as to leave the welder a minimum of discretion; "we will have welded failures as long as drawings go to the shop simply marked 'weld here.'" The foundry still has its place in the picture for certain parts which can be made cheaper of cast steel than rolled steel. The ideal fabrication is one which is a most economical combination of the two fabricating procedures.

Savings in weight are reflected not only in the first cost of the assembly, but in transportation, foundations and erection costs. Defective material is disclosed in the rolling process and is rarely found in machining after welded fabrication as is so frequently the case with castings. Welding permits carrying a small stock of parts in small space, to be fabricated quickly on demand. Designs can be changed more quickly than when new patterns are necessitated. Machining of welded jobs is generally less and quicker deliveries are thus made possible.

Several instances were cited by the author in which these and other advantages were realized. A new shear frame was welded out of 1-in. and 3-in. plates in the same time it would have taken to make a new pattern for casting. A welded steel clamp for a revolving car dumper weighed 19 per cent less than the cast one; the cast ones were continually breaking in service; the user has never had a welded rolled steel clamp break even with the reduction in weight. A 60-in. gate valve for a low-pressure gas line was fabricated by welding, half the weight was eliminated and the recurrent breakage previously experienced was likewise eliminated.

A New Portable Multi-Purpose Oscillograph

By KIRK A. OPLINGER*

Research Laboratories, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

ADAPTABLE to a wide variety of general engineering applications is a new portable oscillograph which has the following unique features:

1. Simultaneous viewing and photographing.
2. A continuous time axis furnished by a small revolving mirror whose speed is variable.
3. A new type of galvanometer with electromagnetic damping and high-frequency response.
4. An optical system which magnifies the galvanometer deflections and which give a brilliant trace that can be observed in a brightly lighted room.
5. A simple method of taking photographs similar to an ordinary camera.
6. A large viewing screen for making tracings or for giving demonstrations to a group of persons.
7. Simplicity, compactness and ruggedness comparable with the average electrical indicating instrument.

Outside the field of electrical engineering, the oscillograph has been used for acoustical studies and for the measurement of vibrations, accelerations and pressures. In designing an oscillograph for such applications simplicity and ruggedness are of primary importance, as the instrument will not generally be used by an experienced oscillograph operator. The size of the oscillograph and the ease of making visual observations are also important since the oscillograph will be used much the same as a meter to make comparative measurements of amplitude, phase, frequency or wave shape.

As simple as ammeter or voltmeter

This new instrument may be used as conveniently as an ordinary voltmeter or ammeter and has other characteristics which will extend the range of application of oscillographic instruments. It is entirely self-contained and may be operated from a 110-volt, 60-cycle lighting circuit without auxiliary attachments. The oscillograph is very compact, as shown by its over-all dimensions, which are 8x11½x11 in. Its total weight is approximately 18 lb.

Both galvanometers may be used for measurements of potentials up to 300 volts or currents up to 10 amp. without the use of external resistors. The control switches have a stop to prevent the operator from accidentally switching to the current side when connected to a voltage circuit. However, no damage will result to the instrument if this mistake is made, since both the resistors and galvanometers are protected by fuses.

**Abstract of paper presented at A.I.E.E. annual convention Chicago, June 26-30, 1933.*

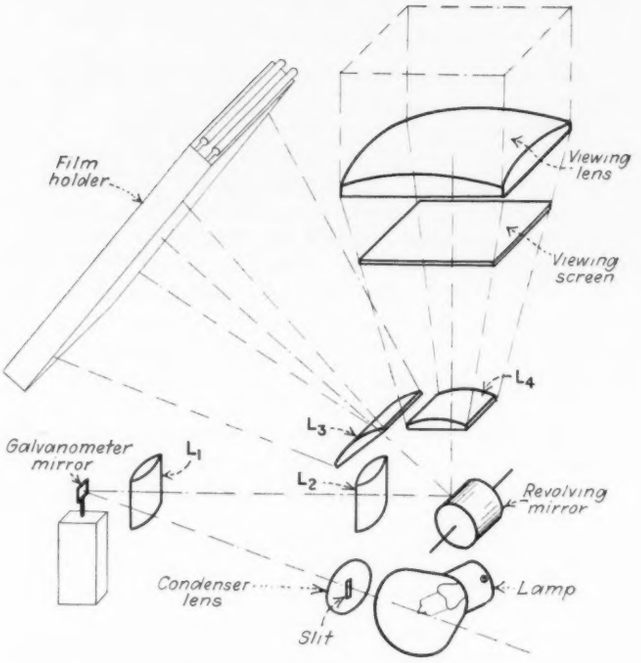
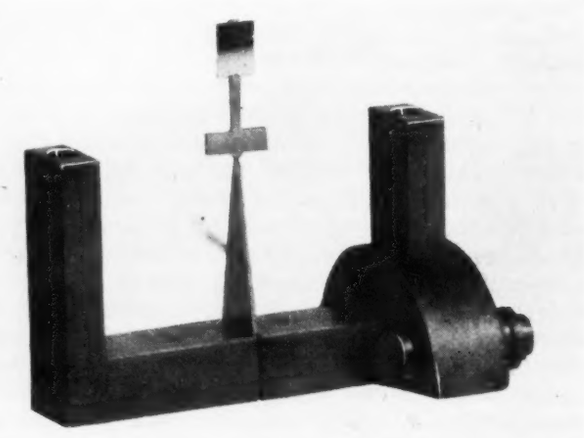
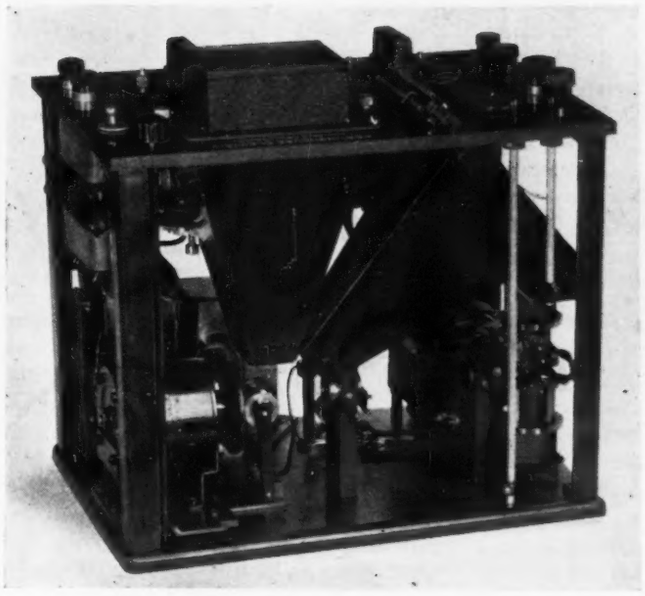


Image can be seen while photographing it

The slit is illuminated by a standard 6-volt, 32-cp. automobile headlight lamp whose filament is imaged on the galvanometer mirror by a small condensing lens. Lenses L_1 and L_2 are cylindrical with their axes at right angles to the axes of the cylindrical lenses L_3 and L_4. Optical multiplication is obtained by means of lenses L_1 and L_2. Lens L_1 gives a reduced image of the slit directly in front of lens L_2. This image, together with any motion imparted to it by the galvanometer mirror, is then enlarged by lens L_2 onto the film. The size of the image on the film, in the vertical direction, is therefore fixed by the width of the slit and the over-all magnification of lenses L_1 and L_2. The other dimension of the image is determined by the height of the slit and the magnification of lenses L_3 and L_4, which focus on the film and screen respectively.



Torsion replaces fragile galvanometer filament



Interior shows basis of compact light-weight design

The small revolving mirror is driven by the friction between a wheel on the mirror shaft and a faceplate mounted on the end of the motor shaft. The speed of the mirror, and hence the timing on the screen, is varied by sliding the motor back and forth to change the driving radius.

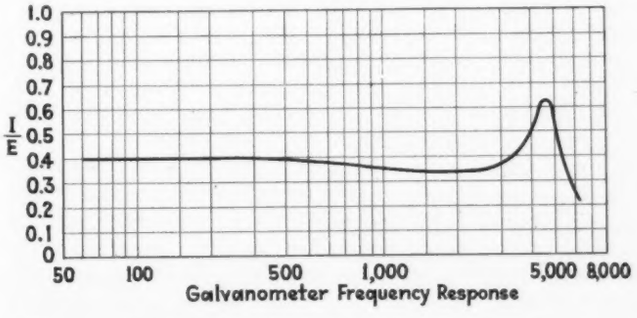
Both film and viewing screen are stationary and in position for use at all times. When it is desired to take a photograph of any recurrent phenomenon it is only necessary to press the "expose" button near the center of the panel. This button opens a shutter to the camera and at the same time places an overvoltage on the oscillograph lamp. Provision has been made to use either a standard cut film holder or pack with $2\frac{1}{4}$x$3\frac{1}{4}$-in. film in a manner similar to an ordinary camera.

The number of faces on the revolving mirror and the angles subtended by the film and viewing screen have been chosen so that there is always a spot of light entering on both the film and screen just as the previous spot is leaving. This arrangement makes it possible to study transient phenomena without the possibility of a transient occurring at a time when the screen is dark.

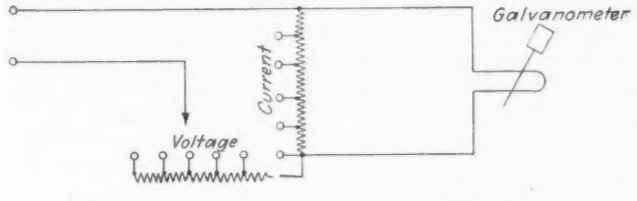
The galvanometers are of the moving iron type with a balanced armature. This design results in a very rugged construction which can withstand large overloads without damage and is particularly suitable for portable work. Permanent magnets of cobalt steel are used to supply a steady flux in the four air gaps. When current flows in the coils, the flux in one pair of diagonally opposite gaps is increased, while the flux in the other pair is decreased, resulting in a force couple which tends to rotate the armature about its vertical axis. The restoring force for the armature is furnished automatically by its support.

The armature support has a 90 deg. twist at the top which places the armature at right angles to the flat, tapered stem. This construction gives the desired torsional stiffness for the armature and at the same time furnishes a high bending stiffness to keep the armature centered in the air gap. The mirror is mounted on a short stem extending above the armature. It is desirable to have this mirror large, since it is one of the limiting factors in the amount of light that is available on the oscillograph viewing screen and film. On the other hand, the mirror size cannot be increased indefinitely, since its inertia must be comparable to that of the armature for optimum over-all performance. The mirror shown in the accompanying illustration is $\frac{1}{8}$x$\frac{5}{32}$ in. and has approximately fifteen times the area of an ordinary oscillograph galvanometer mirror.

The galvanometers are designed for twenty ohms impedance and have a sensitivity of 0.10 ampere d.c. per inch deflection for a 5,000 cycle per second response. The frequency range may be extended simply by increasing the torsional stiffness of the armature support and galvanometers of this type have been used for recording frequencies as high as 14,000 cycles per second.



Electromagnetic damping gives wide frequency range



Single circuit for both E and I oscillograms

Only magnetic damping required

In most galvanometers it is necessary to use some form of mechanical damping, such as oil or rubber, but with the moving iron type it has been possible to get sufficient electromagnetic damping.

Damping is practically independent of temperature. The frequency response characteristic is therefore more satisfactory than that of an oil-damped galvanometer which at low temperatures may be over-damped and at higher temperatures under-damped.

In order to use a single galvanometer for making both current and voltage measurements, the circuit shown in the accompanying illustration was devised. This circuit makes the galvanometer response independent of the resistance of the external circuit. When making current measurements a small resistance having a number of taps is permanently shunted across the galvanometer. The taps give the desired current range and the value of the shunt is such as to give the desired frequency response which is the same for any tap position. For making voltage measurements another resistor is connected in series with the current circuit having taps to cover the voltage steps, arranged so that on the lowest voltage tap there is still sufficient resistance to give essentially a constant current to the shunted galvanometer circuit.

Testing Circuit Breakers for Interrupting Capacity

By R. M. SPURCK and W. F. SKEATS*
General Electric Company

SOME uncertainty still exists as to the correctness of certain testing schemes and possibly some question of the ability of even large laboratories to make tests which definitely establish the ratings of oil circuit breakers of the larger interrupting capacities now being manufactured. There are so many variables in equipment, procedure and interpretation of results that it seems desirable to discuss them broadly in view of the general interest in oil breaker testings. The considerations which are involved, the extent to which these considerations influence the significance of laboratory tests and the steps taken by testing engineers to secure reliable tests are discussed topically.

CO Versus OCO Tests—The present standard interrupting duty cycle† specifies that the interrupting rating of an oil circuit breaker be based on two OCO operations (close on a short circuit and trip). In laboratory tests, particularly on breakers whose fundamental design has been reasonably well established, the OCO tests are used. The CO operation, however, eliminates many variables and produces simpler records from which pressure, speed, arc duration and other data pertinent to an understanding of the breaker performance are readily determined. Also, it is desirable in many cases to take advantage of the higher short-circuit currents made available by pre-tripping; that is, setting the trip mechanism in motion before the short circuit is thrown on. The CO cycle lends itself more readily to this practice than does the OCO cycle. After satisfactory performance is indicated from the CO tests OCO tests are made.

The difference in duty resulting from OCO tests compared with CO tests is that in establishing the short circuit during OCO tests arcing occurs which produces some pressure and contact burning. On poorly designed breakers, particularly those of flimsy construction or with inadequate or improperly designed mechanisms and opening springs, the OCO test may result in unusual stress on the breaker compared with the CO test. On the other hand, by a proper design of such parts as contacts and mechanisms, the arcing on closing during OCO tests can so be reduced that the OCO test is but little more severe than the CO test.

Pre-Tripping—Pre-tripping means that the inherent delay in the tripping and parting of the breaker contacts after the short circuit is applied is eliminated by giving a trip impulse before the short circuit is applied. The principal advantage of this procedure is that the interruption can be started while the generator short-circuit current is near its maximum. Thus greater use is made of output of the generator.

The use of pre-tripping is considered entirely legitimate in breaker testing. It has been questioned primarily on two counts, namely, that interruption may occur while the short-circuit current is very much offset and therefore is easier to accomplish and also that higher than actual current interrupted may be indicated. It will be seen that the relation of those items to the interrupting duty is well understood and can be interpreted readily.

Effect of Frequency—On the older types of plain-break breakers, where the arc duration was long, the results of interrupting tests at 60 cycles and 25 cycles were generally about the same. On the more modern types of breakers, however, particularly those of the oil-blast type, which on low voltages have normal arc durations of not more than a cycle, frequency may have a very decided effect on the breaker performance, the duty being more severe at 25 cycles. The reason for this is that normally the arc will be extinguished at the first current zero. On 60 cycles the first current zero will appear sooner than at 25 cycles, so the arc length on 60 cycles, and likewise the duty, is less. Breakers have sufficient factor of safety, however, so that even though tested at 60 cycles they will meet their full rating when used on 25 cycles.

Power factor not a serious item

Power Factor—It has been frequently stated that as the phase angle between current and voltage increases the difficulty of interruption of the circuit increases approximately in proportion. The reason for this statement is quite obvious, for in the usual case final interruption takes place at a normal current zero. If the current and voltage are in phase this time will coincide with that of the zero of the voltage wave, whereas if the current and voltage are 90 deg. out of phase the time of current zero will correspond to the peak of the voltage wave. Thus in interrupting a purely reactive short circuit the breaker must establish in a fraction of a millisecond, dielectric strength between its contacts equal approximately to the normal peak voltage to be established across them. This reasoning is confirmed by more or less isolated tests within the experience of most testing engineers.

Tests and theory indicate that in the region of a purely reactive short circuit a considerable variation in phase angle may be allowed without greatly affecting the severity of the tests. Thus, while it is felt that the power-factor conditions in factory testing plants are at least as severe as those to be encountered anywhere in the field, it is not felt that any slight discrepancy in this respect should be regarded as seriously influencing test results.

In this connection, however, it should be borne in mind

*Excerpts from paper presented at A.I.E.E. annual convention, Chicago, June 26-30, 1933.

†A.I.E.E. Rule 19-107.

that there is a very appreciable effect upon recovery rate, depending on whether a short circuit limited partly by resistance and partly by reactance has the resistance and reactance in series or in parallel, the parallel case being very much easier. The above discussion applies to the series case.

In the case of leading currents the above conditions may not apply, and in the case of transmission line charging currents the situation is quite different.

Here at the time of the first current zero the interruption is very easy. After interruption the voltage of the transmission line remains constant; the voltage of the source from which the transmission line has been disconnected persists and the difference between the two represents voltage across the circuit breaker. This voltage does not rise abruptly to any appreciable value as in the case of a reactive short circuit, nor does it even begin to rise with an appreciable rate as would be expected in the case of a resistive short circuit. The rate of rise is initially extremely small, and thus an initial interruption at least may be expected with a very small contact separation in almost any type of breaker.

One-half cycle after this initial interruption, however, twice normal peak voltage appears across the circuit breaker contacts. In view of the short gap at which the initial interruption took place, this may be sufficient to break down the gap. This may take place at a comparatively low voltage in the case of an air-break breaker, but it does not usually take place with oil circuit breakers on systems operating at less than 110 kv. When this breakdown does not occur the circuit has been finally interrupted at a very short arc length. When a breakdown does occur, however, subsequent oscillations may take place which can build up voltage across the circuit breaker to very high values, 5½ times normal peak voltage having been recorded on a transmission line in the field, and the theoretical maximum possible being almost unlimited.

Thus the interruption of line-charging current may be the easiest duty the breaker has to perform on a low-voltage system or may draw arc lengths approaching those obtained on short-circuit conditions on a high-voltage system. It must be remembered in this connection that the line of demarcation between what is here termed a low-voltage system and a high-voltage system depends entirely upon the breaker and may be well above any voltage in commercial use for some types of breaker.

Deceleration—In most cases the alternator furnishing the power for factory interrupting capacity tests is driven by a motor just large enough to supply the no-load losses of the alternator. The question has therefore arisen as to the extent of generator deceleration due to the additional losses occurring in generator, buses and reactors, and circuit breaker at the time of a circuit-breaker test. Should this deceleration be appreciable the frequency and voltage will of course be reduced in the same ratio as the speed of the alternator. Measurements taken on the machine used by the General Electric Company, however, indicate this deceleration is negligible.

Decrement Curves—The decrement of the short-circuit current affects the interrupting duty of the circuit breaker in two ways:

1. The arc current is slightly decreased from the time of contact separation to the time of interruption. Thus contact burning and oil deterioration are very slightly less than would be obtained with the same initial current in the arc and no decrement. Obviously, the decay of both a.c. and d.c. components enters into this effect.

2. The recovery voltage is reduced, neglecting saturation, in the same ratio as the reduction in the a.c. component of current from inception of short circuit to interruption. The effect of saturation is to decrease somewhat the amount of this reduction.

On both of these scores, therefore, the present A.I.E.E. specifications give the breaker credit for slightly more severe duty than it has actually withstood, for the reason that the current at the time of contact separation and the voltage before short circuit are used in the calculation of the severity of a test. However, as the decrement of the a.c. component in factory testing plants is usually steeper than is obtained in the field, these effects tend to make factory tests slightly less severe than field tests. With machines approximating standard design and breakers built to interrupt with a short arc duration and a short total duration of short circuit, however, both these effects are small enough so that the additional labor required in order to make a precise correction does not seem warranted, the maximum reduction in recovery voltage which might normally be expected in the testing plant of the company being about 25 per cent, as against a reduction of 10 to 15 per cent to be expected on an operating system. In the matter of current the discrepancy is probably even less, not exceeding 5 per cent.

Grounding affects internal voltages

Effect of Grounding the Short Circuit—The effect of grounding on a single-phase short circuit is primarily a matter of voltage distribution within the breaker. In the plain-break breaker, if one terminal is at ground potential, one break is likely to take the principal part of the recovery voltage, rendering the other break or breaks more or less ineffective, whereas if the two terminals are at equal but opposite potentials with respect to ground, approximately one-half the voltage will be applied to each of two breaks. With breakers employing special interrupting schemes, this effect is less likely to exist, for the arc lengths are in general shorter, and this, in combination with the additional material used about the contacts, tends to increase the capacitance across the gap and thereby promote equal division of voltage.

The grounding of the neutral of a three-phase short circuit has several effects:

1. The magnitude of the recovery voltage to be established by the first pole to clear is considerably reduced.

2. One terminal of this pole is, however, at ground potential, whereas in the ungrounded case one terminal is in general at plus ⅔ of the total voltage with respect to ground, while the other is at minus ⅓. This tends to favor the ungrounded condition, as explained in the first paragraph under this heading.

3. In the ungrounded condition the interruption of the first phase is the most difficult, whereas in the grounded condition the interruption of the last phase is likely to be so. Hence in the ungrounded condition there are three poles working simultaneously on the hardest task, while in the grounded condition the hardest task is left for one pole to accomplish. And, furthermore, if there is any difference in the interrupting characteristics of the three poles, the one clearing last is likely to be the weakest.

The grounding of a three-phase short circuit, therefore, introduces tendencies in both directions, and the balance will be determined by the relative weight of the opposing factors in the particular case.

The above discussion is predicated upon a system whose neutral is grounded. When the short circuit is ungrounded it makes little difference whether or not the system neutral is grounded. A three-phase grounded short circuit on an ungrounded system, however, has the same properties as an ungrounded short circuit with the following minor exceptions, the first of which tends to increase and the second to decrease the severity of the tests:

1. One terminal of the first phase to clear is at ground potential and the other at full potential above ground.

2. The recovery characteristic will have oscillations at two or more frequencies, at least one of which will be comparatively low, not more than two-thirds of the total recovery voltage being associated with the high frequency oscillation.

In the General Electric laboratory tests are normally made with the short circuit grounded, but the system ungrounded.

Relative Severity of Single-Phase and Three-Phase Tests—In both the factory and the field it is often found convenient to deduce the performance of the breaker on three-phase short circuits from its performance on single-phase tests. In such cases tests on a single pole may be made at leg voltage (58 per cent of line voltage), at 1.5 times leg voltage, or at full line voltage, depending partly on the application of the breaker and partly on the judgment of the testing engineer.

Tests at leg voltage are justified where the breaker is to be applied on a solidly grounded system and one so laid out that a three-phase ungrounded short circuit is impossible. Such arrangements are rare, however, and this type of test is very rarely sanctioned by the General Electric Company.

The choice of 1.5 times leg voltage arises from the fact that, in a location where the irregularities introduced by synchronous machinery have been smoothed out either by the predominance of other types of apparatus (current-limiting reactors, transmission lines, cables, etc.) or by the presence of amortisseur windings, this voltage is encountered by the first phase to clear of a three-phase ungrounded short circuit. There are, however, additional factors, varying somewhat in importance from one application to another, which tend to affect the performance of the breaker. Thus the presence of synchronous machinery tends to increase the voltage which may be expected in the three-phase ungrounded condition, although this tendency may be practically eliminated by an amortisseur winding, or, to a lesser extent, by the iron of a solid steel round rotor. On the other hand, the fact that three poles are attempting to clear the circuit at different times and that success on the part of any one renders the task much easier for the two others tends to increase the probability of clearing the circuit on three-phase tests in the early part of the region in which the circuit is interrupted in single-phase tests.

Decrement factor low for 3-phase shorts

An additional consideration of slight importance lies in the fact that the decrement factor is lower in the case of three-phase short circuits than in the case of single-phase short circuits, resulting in a slightly lower recovery voltage for this case for the same short-circuit duration.

The use of full line voltage for single-phase tests has in general no theoretical basis, but is sometimes used in both laboratory and field tests, either because it is inconvenient to underexcite to the lower voltage or because more power is available at the higher voltage.

In the General Electric Company tests are usually made at 1.5 times leg voltage, or 87 per cent of line voltage, and assurance is obtained that a liberal factor of safety is available even at this voltage, particularly when the breakers are likely to be applied where abnormally high recovery voltages may occur, as in the interruption of three-phase short circuits where power is largely supplied by waterwheel generators without amortisseur windings and without appreciable external reactance.

Stated in another way, in order to rate a three-phase breaker on the basis of tests on a single pole, the current interrupted by the breaker with a reasonable factor of safety is taken as the current which the breaker may be called upon to interrupt in three-phase application, and the test voltage is increased 15 per cent to give the line voltage of the system on which the breaker may be applied. The three-phase kva. is thus $\sqrt{3} \times 1.15$ times, or twice the single-phase kva. obtained in test, with a proper margin of safety on both current and voltage.

Effect of Displacement—Displacement of the current wave, as is well known, has the effect of increasing the r.m.s. value of current. It also tends to render interruption easier by reducing somewhat the instantaneous value of recovery voltage. While the instantaneous value of recovery voltage may be reduced to zero in the case of a fully displaced wave, interruption is, as a rule, very difficult to accomplish before some decay has taken place in the direct-current component of short-circuit current, and a small amount of decay in this component brings the recovery voltage comparatively close to that existing for a symmetrical current wave. For example, a wave with an 80 per cent d.c. component has 60 per cent of normal recovery voltage and a wave with 60 per cent displacement has 80 per cent of normal recovery voltage.

Shunts and Current Transformers for Current Measurement—From the point of view of accuracy either shunts or current transformers may be used for current measurement, provided that they are properly designed and due precautions are taken with the secondary circuit. In the case of shunts a standard design large enough from the heating standpoint and capable of withstanding the electromagnetic forces is satisfactory provided the drop lead is attached in the proper location and the spacing between conductors is sufficient so that no eddy currents are generated in one shunt by the flow of current in a neighboring conductor.

In the case of current transformers the heating, electromagnetic stresses and spacing must also be considered, and in addition consideration must be given to the section of iron to be sure that it is sufficient to record the d.c. component without saturation. Saturation errors are much more serious in the case of a current transformer with secondary windings on one or two legs of a rectangular frame than in the case of a transformer with secondary windings uniformly distributed about a circular frame. Thus, a special check must always be made of the secondary burden and the design of current transformers to be used for the measurement of short-circuit currents and in many cases especially designed current transformers may be required.

Effect of Amortisseur Winding—An amortisseur winding increases the initial short-circuit current obtained from a generator, but the increased current thus obtained is subject to a rapid decay. Thus, if a short circuit is interrupted within four or five cycles after its initiation the current may be increased some 10 per cent on account of the amortisseur winding. Beyond this point, however, the increase in current due to this cause is negligible. At the time of interruption the recovery voltage will be decreased in about the same proportion as the initial short-circuit current is increased by the amortisseur winding unless the duration of short circuit is very short, in which case the normal voltage will be approached.

In the case of three-phase, ungrounded short circuits the lack of an amortisseur winding may cause excessively high recovery voltage upon interruption of the first phase to clear. This renders the duty of the circuit breaker consideraly more severe when interrupting a three-phase, ungrounded short circuit in a machine of this type.

Arc Energy—A ballistic wattmeter which will indicate the instantaneous values of current and arc voltage is a part of the equipment of most interrupting test laboratories. Readings of arc energy are readily obtained, and it is customary to take such readings for all interrupting tests.

It has not been found that arc energy has any consistent relation to the current interrupted. The readings are taken merely to give a general indication of the breaker performance and are used only in the analysis of results.

Effect of the Form of the Recovery Characteristic—In the great majority of cases the factor determining the recovery characteristic‡ is the capacitance present in the system and its location with respect to the system reactance and the circuit breaker. A large capacitance to ground, located between the breaker and the principal reactance of the system, tends to delay the appearance of voltage across the breaker and give rise to a mild recovery characteristic, whereas the lack of such capacitance causes a steep and therefore severe recovery characteristic. For this reason a breaker used to isolate a fault from a bus to which are connected a large number of transmission lines or cables, if there is no appreciable reactance either between the fault and the breaker or between the breaker and the bus, will have a mild recovery characteristic. If, however, a current-limiting reactor or a transformer is inserted in the circuit close to the breaker on either side the recovery characteristic may become very severe. A special instance of the transformer case is that in which the breaker is used to protect a mercury-arc rectifier installation. The duty of such a breaker has long been known to be severe, but it is only recently that the explanation has been found in the recovery characteristic.

The feeling has been prevalent in the past that the recovery characteristics obtained in the field were always less severe than those normally obtained in factory testing plants. While this situation undoubtedly prevails in the great majority of cases, a few exceptional instances have arisen of late in which the field recovery rate was several times the factory test rate on standard connections. In such cases it is possible to set up a special arrangement in the factory whose recovery rate will equal that to be obtained in the field.

Very High Speed Breakers a Special Case—In the case of breakers which clear uniformly on the first normal current zero after separation of the contacts the duty imposed on the breaker may vary over wide limits, depending on the time in the current cycle when the contacts are separated. Thus, if separation occurs a very short time before current zero, the current in the arc may not exceed a few thousand amperes, although the r.m.s. value of short-circuit current may have been as high as 50,000 amp. In such a case the circuit often is opened with no perceptible evidence of short circuit on the part of the breaker.

If, however, the contacts separate at the beginning of a current loop, arcing will continue throughout the remainder of the loop and a comparatively large amount of gas will be generated. In comparison with the other case, a rather large disturbance may be noted when this occurs, although with this type of breaker the distress is not severe in any case.

In the case of a displaced wave the range of variation of breaker duty is likely to be considerably greater than in the case of a symmetrical wave, both because the rate of change of current is less in the neighborhood of current zero and because the maximum possible duration of current is greater.

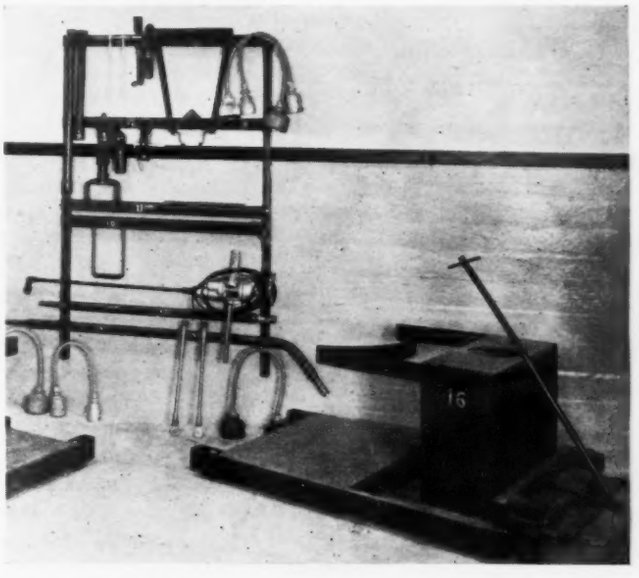
‡*"Circuit Breaker Duty Affected by Characteristics of Circuits," W. F. Skeats,* ELECTRICAL WORLD, June 27, 1931.

Extrapolation—Extrapolation of results of tests on plain-break breakers is particularly difficult because of the erratic performance of the breaker and the extent to which its arc duration increases with increase in voltage. When necessary to extrapolate for plain-break breakers the most satisfactory method is to test at rated voltage and varying current up to the limit of testing facilities. From these tests a kva.-pressure curve is plotted which, if enough tests have been made and the curve has a definite trend, may be extended a reasonable distance within the known pressure limits of the breaker structure. It is not considered even reasonably dependable to extrapolate from tests made at rated current, but at a reduced voltage, because there is little or no assurance that the arc length at the reduced voltage will approximate the arc length at the same current at normal voltage. Also, the susceptibility of the plain-break breaker to variation in recovery voltage may give very misleading results from such tests.

Most oil-blast breakers have the property that the arc length is nearly constant over a wide range of voltage. Therefore, the stress on the breaker at any current is about the same regardless of the voltage. The procedure in making extrapolation tests on oil-blast breakers is to test at rated voltage at currents as high as are available. These tests will establish the arcing characteristics and check the design for consistent arc length. The tests are then carried on at a lower voltage where more current can be produced. As long as arc lengths even at the lower voltage are approximately the same length as those at the higher voltage it appears reasonable to base the rating of oil-blast breakers on the product of volts and amperes obtained from a separate series of tests.

▼

Convenient Rack for Switchgear Accessories



Metal-clad switchgear tools neatly arranged on this simple rack save operators' time and limit the possibilities of misplacing parts. Interesting is the electric motor-driven drill adapted, by the addition of a long shaft and swivel socket, to operate the lowering and elevating mechanisms of the circuit breakers.

New Tests Disclose Causes of Cable Deterioration

By K. S. WYATT, E. W. SPRING and C. H. FELLOWS*

Research Department, Detroit Edison Company.

FROM the time that an oil-and-paper-insulated high-tension cable is placed in service underground a gradual deterioration of the insulation takes place which manifests itself in an increasing dielectric loss. Knowledge of the causes of the deterioration has appeared important because the increasing dielectric loss, besides representing an economic loss, is a threat to the service life of the cable. Little exact information has been obtained, however, because of the great difficulty attending the precise measurement of physical and chemical changes in oil, rosin and paper of cable insulation.

The conception that deterioration of the insulation occurs non-uniformly between sheath and conductor and that such non-uniformities might yield a clue as to the origin and nature of deterioration has led to the development of two new procedures for measuring the electrical and chemical characteristics of aged insulation in a radial direction, layer by layer, from sheath to conductor. The first necessitated the design and construction of a cell for measurement of power factor of individual paper tapes. The second was the development of a procedure for the determination of oxidation products in the oil from individual paper tapes.

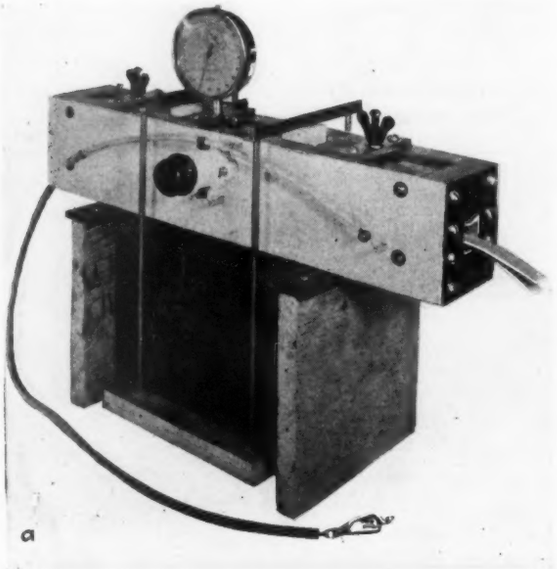
**Abstract of paper presented at A.I.E.E. annual convention, Chicago, June 26-30, 1933.*

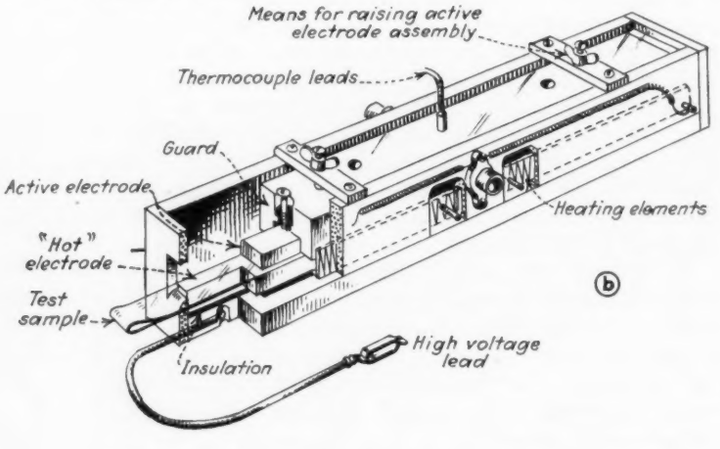
The radial method, involving the use of these two procedures, has been applied to more than 40 samples of new and aged three-conductor, 24-kv. H-type cable. The power factor and oxidation products measured, layer by layer, from sheath to conductor usually yield radial curves which are flat for new cable, U-shaped for deteriorated H-type cable, double U-shaped for deteriorated belted cable. Where no moisture or wax is present in the insulation the character of the radial power factor and oxidation curves is very similar. In cases where ionization has occurred, as indicated by the presence of wax, a radial plot of oxidation products and of wax (by estimation) in most cases explains the variations of the radial power-factor curves. Thus in the absence of moisture the nature and source of deterioration may usually be determined.

Application of the radial method to a number of used cables leads to the following conclusions:

1. Deterioration of cable insulation in a radial direction is non-uniform.
2. A major cause of deterioration of solid-type cables in service is oxidation. Oxidation also causes deterioration of cable during storage in the cable yard.
3. Leakage of air into and along the cable, either at time of installation or during operation, and air occluded in the cable at time of manufacture, is probably responsible for the oxidation of the insulation.
4. Ionization, as indicated by wax deposits, does not appear to cause sharp increases in dielectric loss.
5. The deterioration of three-conductor cables is frequently markedly different on one core than on the two others.

Fig. 1—Cell determines cable tape power factor





(a) Assembled apparatus. (b) Details of electrode box Small openings at each end of the box permit paper tapes to be inserted between the two electrodes for measurement. Resistance heaters installed in the two slotted side walls provide for elevation of the temperature. All metal parts are of brass. Sensitivity is increased by the use of extra-long electrodes (18 in.)

Accuracy has been obtained by careful guarding of the active electrode; since the latter is only $\frac{1}{8}$ in. in width, the usual $\frac{7}{8}$-in. tape overlaps the electrode by $\frac{3}{16}$ in. on each side. The ease with which the sample may be introduced into the cell, properly aligned and the electrodes adjusted, and the short time required for the tape to come to temperature equilibrium make for rapidity of measurement.

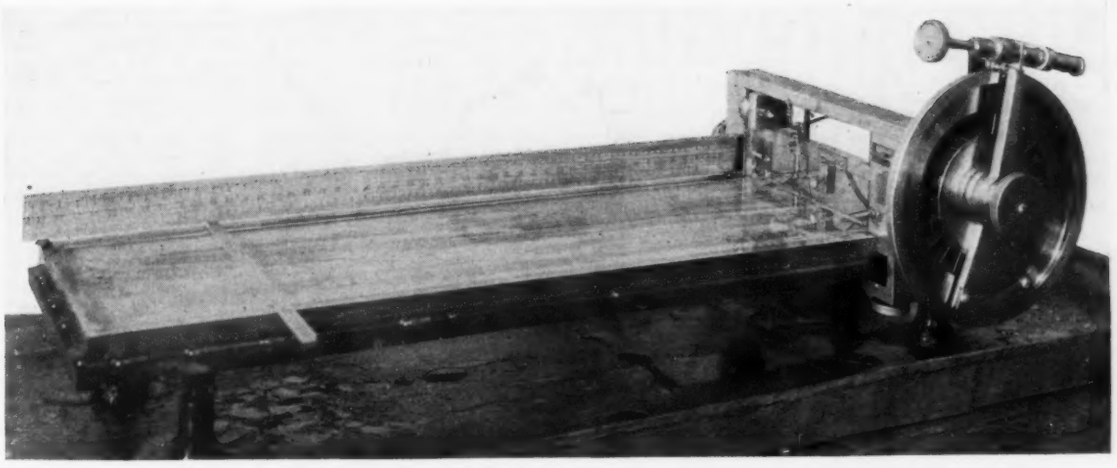


Fig. 2—Film pressure balance measures oxidation products of oil

The new tools will be useful in determining the nature and source of the deterioration which goes on in cables in storage and in service and how this deterioration progresses with years of service. They should also show the part that leaky joints and potheads play in causing deterioration and the remedial effect of oil reservoirs. They should throw new light on many abnormal types of deterioration. In addition the new tools should be helpful in checking and improving the manufacturing processes. In all cases where deterioration is experienced with thin laminated insulation, as in cables, condensers and transformers, they should constitute a valuable diagnostic method.

Power factor cell for paper tapes

In designing a practical cell for the measurement of power factor of individual paper tapes it was necessary to meet four requirements: Sensitivity, ability to maintain a constant elevated temperature during operation, accuracy and rapidity of operation.

The completed instrument (Fig. 1) is extremely simple in design. Essentially it consists of a long rectangular metal box, in the bottom of which is mounted the high-voltage electrode. A long metal bar or block fitting snugly into the top opening of the box and capable of being raised and lowered constitutes the active electrode assembly. The large amount of metal used provides a heat reserve which insures against variations in temperature due to the introduction of each new sample.

In order to eliminate the effects of wrinkles in the tapes or of excess compound pressure is applied to the movable electrode. After determining the change of power factor over a range of pressures a value of 6.4 lb. per square inch, above which no appreciable change of power factor was noted, was selected as standard for all measurements. The thickness of the paper tapes in the cell is indicated by a dial gage. The latter provides a useful means for determining the voltage to be applied to the electrodes when a constant stress per mil is being used for measurement. The equipment used to determine the power factor was a modified Schering bridge.

The procedure in using the cell for the measurement of power factor of cable insulation layer by layer is as follows:

The lead sheath is removed from a 2-ft. sample of cable. The shielding is removed from a conductor and the first layer of paper tape carefully unwrapped. Six inches is clipped from each end and discarded. A short length is next cut off for the hydrophil determination to be described later. The tape is then folded in two and inserted by means of a long, thin metal guide strip into the test cell, the latter having been brought to 60 deg. C., the temperature decided upon as standard for this work.

A similar procedure is followed with each selected tape down to the conductor. Usually each fifth layer only is tested, except in the vicinity of the shielding and of the conductor, where sometimes it is desirable to test every layer.

In operation the time required from the unwrapping of a paper tape to the completion of the power-factor measurement is only three minutes or less, an interval which has been shown to be sufficiently short to make the effects of moisture adsorption or oxidation negligible.

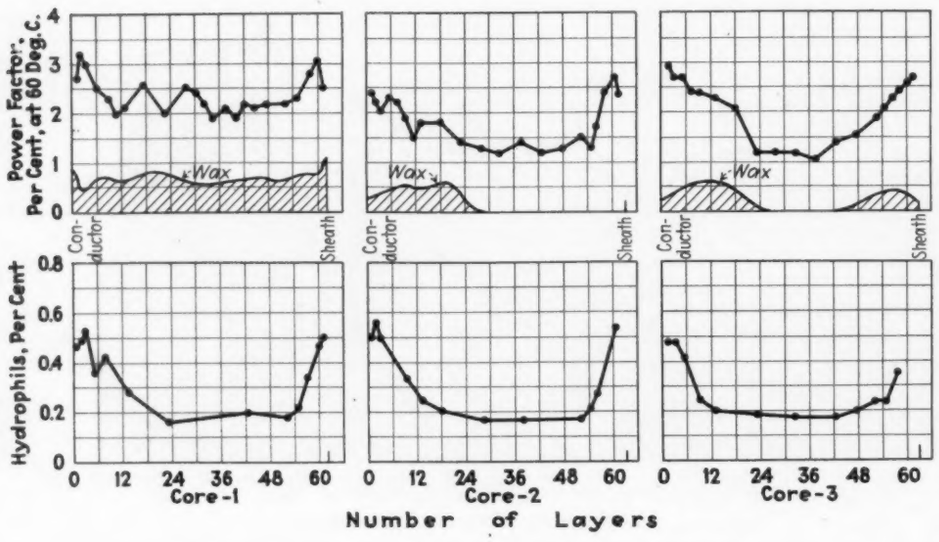
A constant stress of 50 volts per mil is used rather than a constant voltage across the electrodes.

Oxidation by hydrophil test

The hydrophil test is an extremely useful method of determining the total oxidation products in an insulating oil. An exceedingly small sample of oil is required; as little as 1/100 gram may be taken, as compared with 20 grams for the standard acid number test. Furthermore, the method indicates the total content of oxidation products in the oil including acids, alcohols, esters, ethers, and all other oxidation products, whereas the acid number is an indication of the amount of one type of oxidation product only. The number of oxidized molecules determined by the hydrophil method may be more than twenty times as great as that calculated from the acid number. The electrical characteristics of oil oxidized by contact with air are in general influenced more by the total number of oxidized molecules than by the number of any one type of oxidation product that may be present.

The hydrophil content of an oil is determined by dropping on a water surface a known number of oil molecules, the number being calculated from the weight or volume of oil used. Those molecules which contain only hydrogen and carbon atoms are inert and will remain grouped as a lens without spreading. Those molecules which contain oxygen atoms are attracted by the water and spread out in a layer one molecule deep. The number of oxidized molecules is obtained by measuring the area of the spread and dividing this value by the area occupied by each such molecule on the water surface, which is known within narrow limits.

The apparatus is of the torsion type and consists of a long shallow paraffined brass tray on which is mounted



The characteristic U-shaped correspondence between power factor and hydrophils is best shown by cores 2 and 3 with the least wax. In this case the hydrophil curves do not explain the power-factor curves as well as in the other examples given. The explanation appears to be that in addition to oxidation another aging factor is present, namely, ionization. This is borne out to some extent by the curves for conductor 1, where the least correspondence is apparent between hydrophil value and power factor, but where ionization as indicated by the wax deposits has occurred with considerable intensity uniformly from conductor to sheath. The effect of ionization appears to have been to raise the middle portions of the power-factor curves for conductors 2 and 3 from about 1.2 per cent to about 2.2 per cent. In any case the general level of power factor of conductor 1, where wax is in abundance throughout the insulation, is higher than in the other conductors where no wax is present in the middle portion of the insulation.

Fig. 3—Power factor of cable tapes after four years of service

a torsion head (Fig. 2). On the water with which the tray is filled rests a paraffined metal float which is connected to a mirror and to the torsion device. Pressure against the float is measured by reading the angle of torsion required to return a beam of light reflected by the mirror to the zero point on a vertical scale.

In operation a given amount of oil, usually in benzol solution, is dropped on the water surface. The resulting film is compressed by moving a paraffined glass barrier toward the metal float and the pressure against the float determined by the torsion device. The area of the film at this pressure is then measured. Other force-area readings are obtained by moving the glass barrier to several positions and reading the corresponding pressures. By plotting the force-area curve and extending it to cut the area axis the area of the film at zero compression may be determined more accurately than by other methods such as those involving the use of a talc barrier. Knowing this area and the weight of oil placed on the water the percentage of oxidation products may be calculated from the formula:

$$\text{Per cent hydrophils} = \frac{A \times M \times 100}{a \times w \times N}$$

where A = area of film at zero compression, sq.cm.
a = area occupied by one molecule on water surface, sq.cm.
M = average molecular weight of the oil.
w = weight of oil placed on water, grams.
$N = 6.06 \times 10^{23}$ = number of molecules in a molecular weight of the oil.

In applying this formula, the area occupied by each oxidized molecule is assumed to be constant, although it actually varies between 20 and 25 square Angstrom units (20 to 25 $\times$ 10^{14} mm.^{2}) for most oxidized oils, and in some cases the values may be considerably greater than 25 square Angstrom units. The molecular weight of cable oils, which usually varies from 300 to 600, need not be known for comparative work, as an average value may be assumed; however, if results closer to the absolute are desired the molecular weight of the oil should be determined.

The area of spread per gram of oil for the different layers between sheath and conductor is reported as percentage of oxidation products on the assumption that the molecular weight of the oil in each case is the same.

As the paper tapes are removed one by one for measurement in the power factor cell a 3-in. to 2-ft. length is clipped from each, cut into ½-in. pieces and dropped into a glass bottle containing 5 to 10 cc. of benzol. After standing for about three hours in contact with the paper the benzol solution is shaken up. Exactly 5 cc. of solution is pipetted off, the benzol evaporated and the residue weighed; in this manner the concentration of the oil in the solution is determined. At the same time a 0.1 to 1 cc. of solution is drawn off in a standardized 1 cc. pipette and placed on the water surface of the film pressure balance. The area of spread, and from it the percentage of hydrophils, is then determined in the manner already described.

Application of the radial method to aged cable

With the aid of the methods described above some 40 samples, selected from three-conductor, 24-kv. H-type cable, new and aged, have been investigated in a radial direction. All were impregnated with straight mineral oil unless otherwise stated.

Curves were obtained from cable of 1930 manufacture. The sample tested was cut from the center section of a 45-ft. length which had been on accelerated aging under continuous double operating voltage for about 2,700 hours. During the initial heating and cooling cycles a small amount of compound leaked from one pothead. The high values for oxidation products and power factor at conductor and sheath might therefore be explained on the basis of air leakage at the pothead, along the copper conductor and along the filler spaces, followed by radial penetration of the insulation.

In contrast to the results obtained with service-aged cables the radial power factor and hydrophil curves for new cable of 1931 manufacture are flat. From all these curves it is clear that deterioration of cable insulation in a radial direction is non-uniform and that the form of the radial curves may give some clues as to the nature and cause of such deterioration.

In most cable samples all three conductors were examined for uniformity as to radial characteristics. The results for the three conductors of a 1928 mineral oil cable aged one year in service are shown in Fig. 3. In addition to radial power factor and oxidation curves, the amount of wax present in the insulation is indicated as estimated by visual examination.

An interesting example of differences in degree of deterioration of three adjacent conductors is that of a cable which had been subjected to accelerated aging for 4,000 hours (Fig. 4). Upon entering the inner 30 layers of tape which contain heavy deposits of wax the power-factor curves turn downward. The wax was present in an unusual form; instead of the usual flaky appearance, it looked more like a highly viscous gum which pene-

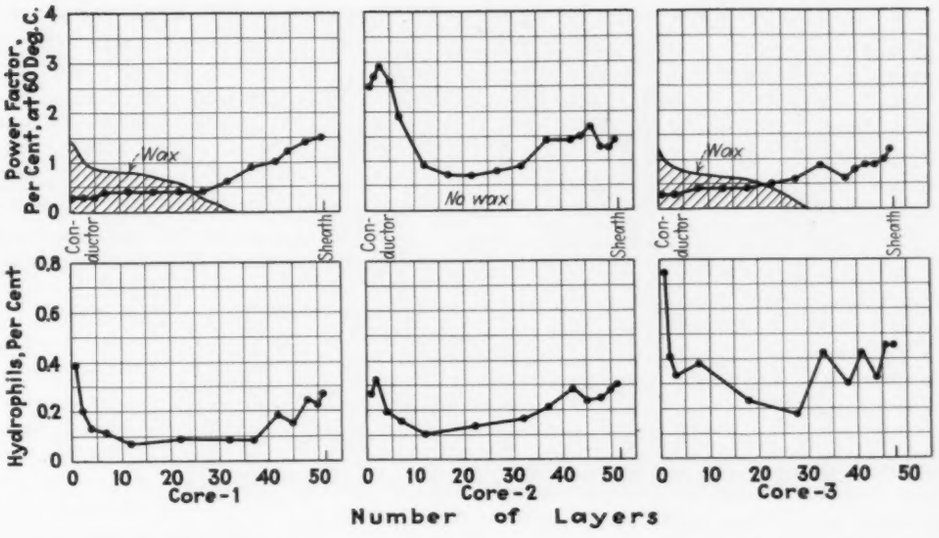


Fig. 4—Power factor of cable subjected to laboratory aging

Core 2 with no wax shows the correspondence of hydrophils and power factor, U-shaped in character. A general agreement can be observed between the character of the power-factor and hydrophil curves of conductor 2 in which no wax was present; hence in this case the deviation of the radial power factor from a straight line may be satisfactorily explained as due to oxidation. In the case of conductors 1 and 3 there does not appear any marked similarity between the hydrophil curves and the power-factor curves.

trated the paper, cementing adjacent tapes so tenaciously together that they could not be separated without tearing.

The radial method has also been applied to cables of the belted type. Instead of the single U-shaped curve between conductor and sheath, often found on H-type cable, a double U-shaped curve has been obtained on the several samples so far examined as both power factor and hydrophil curves are plotted from conductor to sheath across the core and belt insulation. The results on one conductor and the belt of a petrolatum cable after eight years in service are shown in Fig. 5. In obtaining the hydrophil curves some difficulty was experienced due to the rigidity of the oil film on the water. It was found necessary to measure the total area of spread in place of obtaining the customary force-area readings, with consequent sacrifice of accuracy. However, previous work on belted cable leaves no doubt that the radial hydrophil curves are roughly double U-shaped.

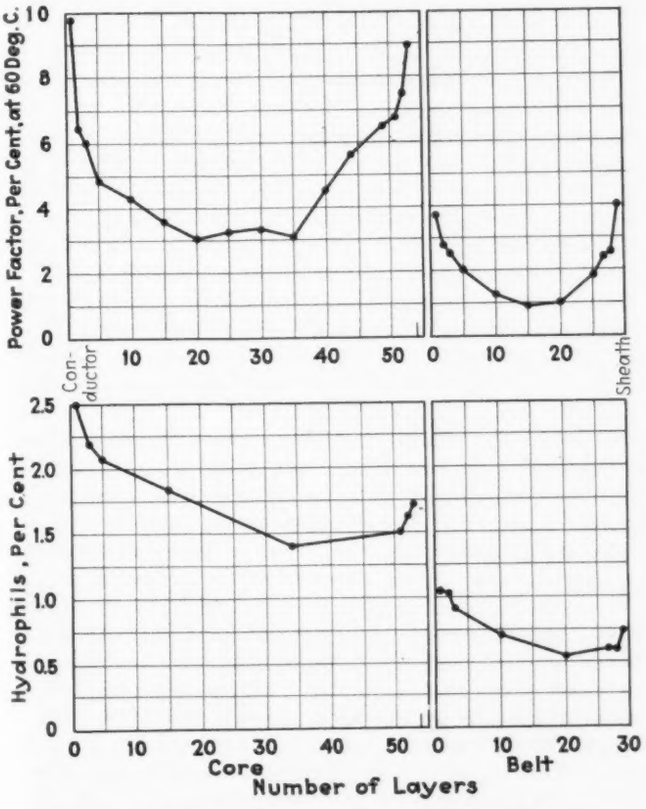


Fig. 5—Petrolatum-impregnated belted cable after eight years of service

Both power-factor and hydrophil values for the belt are lower than for the conductor insulation. This difference may be due either to the lower temperature which is experienced by the belt tapes, since the conductor tapes pass near to the center of the cable where the temperature is highest, or to the different grade of paper which is usually used for the belt insulation.

On older type cables, manufactured previous to 1920 and in service more than ten years, the power-factor curves which have been obtained are roughly U-shaped and of very high value. It is not unusual to find the 60 deg. C. power factor as high as 10 per cent at the lowest point and rising to more than 15 per cent at conductor and sheath.

Discussion

Question arises as to the source of the oxygen indicated by the hydrophil curves. There are five possible sources: Air left in the oil or insulation at time of manufacture, air drawn in at time of installation, air breathed in at porous joint wipes or at imperfections in the lead sheath during load cycles, moisture due to imperfect drying which might be resolved by electrolysis, or the cable paper itself. Considering the paper first, it might furnish oxygen to the oil in two ways, either by splitting off oxygen from the cellulose molecule through the agency of ionization, or by solution in the oil of lignins, resins and associated materials which are present in small amounts in most cable papers. Experiments appear to show that cathode-ray bombardment of oil-impregnated paper in vacuo does not produce oxidation of the oil as a result of disruption of the cellulose molecule, but that the oxygen-containing materials such as lignins, which are present in the cable papers, may be attacked and go into solution in the oil under bombardment. It is possible that under severe ionization they may increase the hydrophil content as much as 1 per cent. The effect of these materials is to promote oxidation of the oil when air is present, and probably to lower the resistivity.

Air occluded in the cable during manufacture or installation, or breathed in at porous joints or leaky potheads during operation, is believed to be the principal cause of the oxidation exhibited by the radial hydrophil curves.

In interpreting the curves stress must not be placed upon the differences in the absolute value of hydrophil content, which will be seen from the figures to vary from cable to cable within rather wide limits without a corresponding change in the power-factor values. It cannot be expected that a constant ratio will obtain between power-factor and hydrophil content, especially when different cable compounds are being compared as in the work just described. The important thing to watch for is similarity in character of the radial hydrophil and power-factor curves.

In comparing the radial power-factor and hydrophil curves attention should be directed only to the correspondence of maxima and minima, since the vertical scale of one or the other could be adjusted to produce an unfair similarity. The same end might also be accomplished by varying the temperature of the power factor measurement; the low portions of the curve would not greatly change position with temperature, whereas the high portions would be sensitive to temperature variation.

The hydrophil and wax characteristics which have been plotted radially for these cables are not always sufficient to explain the variation in the radial power-factor curve. For example, the radial power factor is sometimes found to turn upward near the sheath, whereas the hydrophil curve is flat, even when no ionization has been present. In such a case it is thought that the increase in power factor may be due to moisture adsorbed before the application of the lead sheath.

It is regrettable that so far no method for moisture determination sensitive enough for a tape-by-tape investigation is available.

The radial method should prove of value in determining the distance from joints or leaky potheads at which oxidation effects are obtained. It should also be useful in testing the insulation in the vicinity of failures and in determining the causes of increased dielectric loss in cable aged by accelerated methods. It also provides a means for determining the progress of deterioration with years of service. In addition many abnormal cases of service deterioration occur where the method might yield new information. On new cable the method might be used to detect deterioration due to storage, or to bring to light errors in the manufacturing process, such as the use of oxidized oil for impregnation.

▼ ▼ ▼

Good Reflectors Help Whiten "Daylight" Quality

By M. LUCKIESH

Director Lighting Research Laboratory, General Electric Company, Cleveland

There is some lack of understanding of the so-called daylight tungsten-filament lamps and also some misunderstandings in regard to their use with lighting equipment. Color temperature in degrees Kelvin is a satisfactory specification of such sources.

The work of a colleague, A. H. Taylor, done in Cleveland, Ohio, has shown that the color temperature of direct sunlight between 9 a.m. and 3 p.m. in September, October, March and April is about 5,300 deg. K. Before 9 a.m. and after 3 p.m. it varies from 4,400 to 5,000 deg. The total light from the sun and a clear or slightly hazy sky shows a color temperature of 5,700 to 5,800 deg. from 9 a.m. to 3 p.m. A totally overcast sky indicated about 6,400 deg., which corresponds closely to Priest's suggestion of 6,500 deg. for "white" light.

The color temperatures (degrees Kelvin) of light from "Mazda" lamps at the time of this investigation were approximately as follows:

	Deg.
Clear lamp, 100-watt,	2,750
Clear lamp, 500-watt,	2,900
Daylight lamp, 100-watt,	3,600
Daylight lamp, 300-watt,	4,250
Daylight lamp, 500-watt,	4,500

A glassteel diffuser with "noon-sunlight globe" and a 300-watt regular "Mazda" lamp produced light of 6,200 deg. K. And quite satisfactory filters in the form of plates are available to produce artificial daylight throughout the range of clear blue skylight.

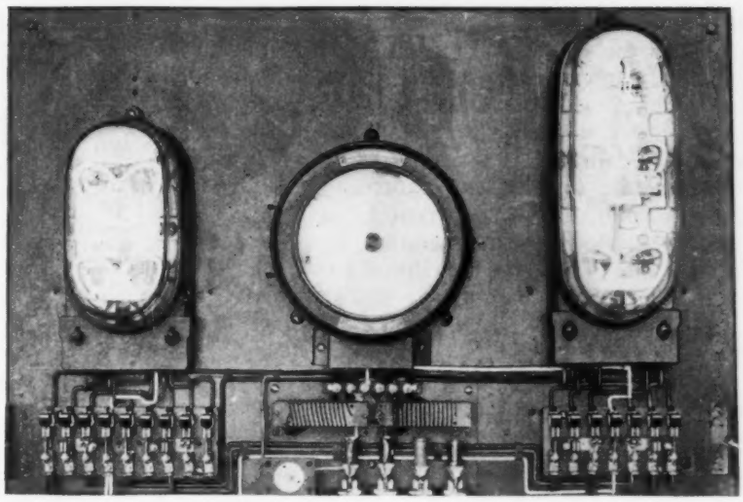
The "Mazda" daylight lamp was originally developed as a true step toward daylight or white light. Practically, it is a compromise between cost and quality of light. The cost is easily computed, but the value is determined by experience with the help of the foregoing data.

Some of the best inclosing glassware of the highly diffusing type appears to have a yellowish tinge. It has been assumed that the color temperature of the light from "Mazda" daylight lamps would be decreased due to the yellowing of the light. Seven typical white inclosing diffusing-glass fixtures, widely approved and in use, were studied first with clear lamps. Five of the fixtures yellowed the light, as if the voltage at the lamp had been reduced several volts, the most yellowish one being equivalent to a reduction of ten volts on a clear lamp uninclosed in glass. A prismatic-glass fixture whitened the light equivalent to a rise of about four volts.

When "Mazda" daylight lamps were tested in these fixtures the light was whiter in nearly all cases than the light from the daylight lamp itself. The increase in whiteness corresponded to an increase of as much as six volts in one case. The only case from which the light was appreciably yellower was the most yellowish of the seven typical inclosing units. The explanation of the increased whiteness of the light when the daylight lamps were used is found in the multiple reflection within the inclosing glass; that is, the light which passes more than once through the greenish blue glass of the bulb.

The absorption of the fixtures was greater for daylight lamps than for clear lamps, but much of this increased absorption is not a loss. It results in whitening the light due to multiple passages through the bulb of the daylight lamp within the inclosing glass.

In glassteel diffusers the light from the daylight lamps was whitened the equivalent of an increase in voltage of as much as 13 per cent. In pendent aluminum open reflectors with excellent oxidized finish the change in color was imperceptible.



Typical polyphase compensating metering panel —Standard polyphase watt-hour meter and connection block at the left. In the middle recording demand meter. Below it the resistor assembly for the polyphase compensating meter at the right.

By GEORGE B. SCHLEICHER

Meter Division,
Philadelphia Electric Company

Primary Energy Measured on Low Side by Compensating Meter

DEVELOPMENT of a "compensating meter" upon the fundamental principle of the watt-hour meter makes possible the elimination of high-tension metering and the consequent economies of metering load and transformer losses entirely on the secondary side. If energy is purchased at high-tension rates the billing is based, as to both consumption and demand, on the sum of the registrations of the regular watt-hour and demand installation and those of the transformer-loss or "compensating meter." Accuracy is at least of the same order of magnitude as primary metering. Independently of the economic and billing advantages the scheme of metering load and losses separately provides data on which to base the elimination of inefficient transformer units or assemblies and thus reduce system losses. Summarized, the new technique is advantageous:

1. When the cost of secondary-plus-loss metering is less than that of primary metering.
2. When limited space requirements make the installation of primary metering more difficult and hence more expensive.
3. When the load conditions are such that the power transformers may be energized for appreciable periods without carrying load.
4. For locations in which primary instrument transformer equipment may be expected to give trouble, due to lightning and other disturbances.
5. When it is desired to obtain registration as of the primary side to a point remote from the metering location.
6. When a customer with a secondary rate and with secondary metering already installed is changed to a primary rate.

Abstract of paper presented at A.I.E.E. annual convention, Chicago, June 26-30, 1933.

The higher the high-tension voltage the greater the differential in cost between high-side and low-side metering. Secondary meters can be adjusted to include transformer losses with the load ("Adjusting Secondary Metering to Include High-Side Losses," by Messrs. Wagner and Schleicher in "Electrical World," February 25, 1933).

A new loss meter is here described which records transformer loss (and line loss too if desired) separately from the conventional load meter. Costing only about $200, it should afford great savings in metering large customers at one point of supply off a high-voltage feeder.

Some cases exist where it would probably not be feasible to substitute this scheme for primary metering:

1. Customers who are supplied by a relatively large number of transformer banks all connected to one primary service.
2. Customers who operate part of their equipment at primary voltage.

In the previous article (Feb. 25, 1933) there was a brief discussion of the variation in transformer losses with variation in loading, temperature, voltage and frequency. That article dealt with the adjustment of the regular watt-hour meter to include the losses along with the registration of the secondary load. In this article the two functions are performed by separate meters. In view of the separation of the functions it is possible to do considerably more in adjusting the metering characteristics to the loss characteristics of the transformers.

Core losses are constant at constant voltage and de-

crease only slightly with rising temperature. They vary approximately as the square of the voltage, but the core reactive kva. vary more nearly as the fourth power of the voltage. This divergence makes an added problem where reactive metering is to cover both losses and load. Copper losses (in watts and in reactive kva.) vary as the square of the current for any temperature. While they do increase approximately 25 per cent from 25 to 80 deg. C. the higher operating temperature is associated with increased load. The error introduced into the load-plus-loss measurement is an extremely small percentage when losses at 75 deg. C. are used in calibrating the compensating meter.

The compensating meter consists of an I^2 element calibrated in accordance with the copper losses and an E^2 element calibrated in accordance with the core losses of the transformers. Both elements are combined on one shaft, as shown in the accompanying illustration.

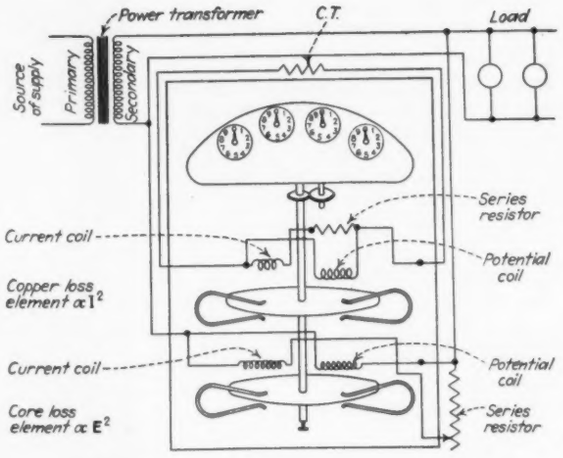
Simplified form for polyphase circuits

The fact that even a relatively large error in the measurement of losses can be negligible in the over-all result has made possible the development of a simplified form for polyphase circuits. Such a meter consists of two copper loss elements and one core loss element mounted in a three-element meter base. This connection is suitable also for closed delta transformer banks. Ordinary load unbalance, such as occasioned by a single-phase lighting load of perhaps 10 per cent of the total, will not result in objectionable errors in metering for load-plus-loss. The same may be said of the effects of voltage unbalance on three-phase circuits. Where large single-phase loads are supplied by a polyphase bank, however, it is advantageous to measure the losses of each transformer.

Loss demand easily obtained

The maximum demand of the loss may be measured with a demand meter by providing contacts for its operation. The maximum loss demand will always be coincident with the maximum load demand in kva. and if the power factor is constant the loss maximum demand will be coincident also with the maximum kw. load demand. In those cases where the loss maximum demand does not coincide with the load maximum demand the error introduced into the combined load-plus-loss demand measurement is negligible, since commercial maximum demand instruments cannot be read closer than 1 per cent. It follows that for customers' installations the maximum loss demand may be measured by an indicating demand meter and added to the maximum load demand. On single-circuit installations the compensating meter may be provided with a watt-hour demand register.

Reactive kilovolt-ampere-hours of transformer losses may be measured with a compensating meter by calibrating it in accordance with the reactive kva. of the core and copper losses. The core loss element should be adjusted at about the average operating voltage, since reactive kva. varies more nearly in accordance with the fourth power of the voltage than with the square as measured by the compensating meter. The error introduced into the determination of power factor is quite small, since for a low power factor customer the reactive kilovolt-ampere-hours of the transformer losses will be a relatively small percentage of the total; near unity power factor a much larger change in reactive kilovolt-ampere-hour is required for a given change in power factor.



Induction meter structure redesigned for loss measurement

The I^2 element (upper) is adjusted by means of the permanent magnets. The E^2 element (lower) is calibrated by means of an adjustable series resistor in its current circuit. Both elements operate on the principle of the induction watt-hour meter. In the I^2 element the fluxes of both the current and "potential" elements are proportional to the line current, giving a resultant torque in accordance with the square of the current. Similarly in the E^2 element the fluxes of both potential and "current" coils are proportional to the voltage, giving a resultant torque for this element in accordance with the square of the voltage.

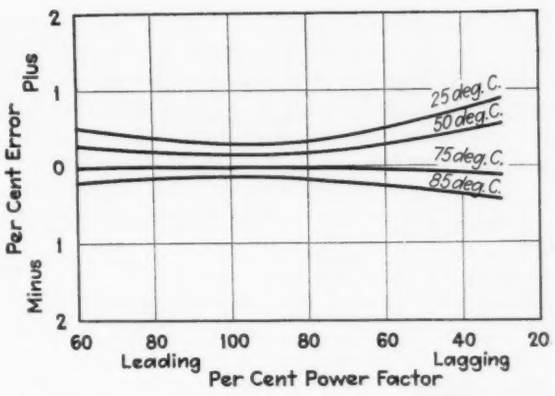
Test results show high accuracy for the method

Test on a 500-kva. transformer bank, one of two banks which supply an office building, showed that the difference between primary metering and secondary metering plus loss metering was less than 0.1 per cent for readings over more than two months. Under operation with no load on the secondary side the primary meter did not record the core losses, since these losses are less than the starting load of the meter. The compensating meter, however, recorded these losses correctly.

Meter compensated from transformer data

In calibrating the compensating meter the copper losses at 75 deg. C. for full load on the transformers are corrected for the full-load meter rating, and this value serves as a basis for the calibration of the copper loss element. Five amperes secondary current represents the kilowatt copper losses which will give a specified speed for the meter disk, and the watt-hour constant may then be calculated. By comparison the nearest standard watt-hour constant may be determined, and thus a standard register may be used for giving registration directly in kilowatt-hours. The speed of the meter disk is then changed to conform to that required for the standard watt-second constant.

In calibrating the copper loss element the potential coil of the core loss element should be energized at normal voltage, but the current circuit of this element should be open. A check for creep may be made under this condition with no current in the copper loss element. The light-load test of the copper loss element is advantageously made at one ampere, for which the disk should



Accuracy is good for wide range of temperature and power factor

The maximum error on a fully loaded 7.5-kva. transformer is within 0.5 per cent for operating power factors between 60 and 100 per cent. The results indicate rather larger errors than will generally be found in service since installations of this type would not generally be made on transformers as small as 7.5 kva. In larger transformers the efficiency is higher and hence the losses are a smaller percentage of the total load.

operate at 4 per cent speed, and the light-load adjustment of the core loss element is used for making the copper loss element record correctly at light load.

The calibration for the core loss element consists of determining the required speed to represent the core loss in conjunction with the watt-second constant determined for the copper loss element. No change should be made in the internal adjustments of the meter after the adjustment of the copper loss element is completed. The resistor assembly of the meter consists of four resistance units (made in various sizes from 250 to 5,000 ohms) and an adjustable resistor of 400 ohms. With the adjustable resistor in the center of its travel the proper units are selected to give approximately the speed required. The exact setting is made with the adjustable resistor, which also serves as the service adjustment for this element. In service it may be necessary to make tests at a different voltage from that at which the meter was calibrated, in which case the core loss watts vary as the ratio of the square of the actual voltage to the square of the calibrated voltage.

Sample Calculations—As an example, consider a bank of three 100-kva. delta-delta transformers, 13,800/230 volts, supplying the total load of a primary customer. It is desired to measure both energy and demand as of the primary side, using a 230-volt, 800-amp., two-element meter and a compensating meter. The secondary metering installation is connected to the power transformer secondaries by three 1,500,000-circ.mil cables, each 20 ft. long.

Calibration of Compensating Meter—(1) The manufacturers of the transformers have supplied the following data:

Transformer No.	Core Loss at Rated Voltage	Copper Loss at Full Load	Per Cent IZ Drop	Per Cent Exciting Current
(a)	380	1,175	4.1	3.0
(b)	360	1,165	4.05	2.8
(c)	372	1,171	4.1	2.9

(2) Total core loss at 13,800 volts = 380 + 360 + 372 = 1,112 watts.

(3) Total copper loss at full load on power transformers (753.1 amp. secondary) = 1,175 + 1,165 + 1,171 = 3,511 watts.

(4) Using 800-amp. current transformers, copper loss at full load on current transformers (5 amp. secondary)

$$= \frac{800^2}{753.1^2} \times 3{,}511 = 3{,}962 \text{ watts.}$$

(5) Copper loss in cables (I^2R)

$$= \frac{800^2 \times 0.0072 \text{ ohms} \times 20 \times 3}{1{,}000} = 276 \text{ watts.}$$

(6) Total copper loss at 800 amp. = 3,962 + 276 = 4,238 watts.

(7) The compensating meter as supplied makes one revolution in 3.6 seconds with 5 amp. in the current circuit. (Both I^2 elements.)

(8) To calibrate the compensating meter to read in kilowatt-hours, the normal watt-second constant would be $K_s = 4{,}238 \times 3.6 = 15{,}256.8$ watt-seconds per revolution of the disk.

(9) To use a standard register, it is necessary to have a standard watt-second constant. By referring to the manufacturers' table of standard registers and constants, the watt-second constants closest to that desired are 17,280 and 12,960.

(10) Either of the above watt-second constants may be used and the choice may properly be made by selecting the one for which the demand scale of the watt-hour demand register provides sufficient overload capacity in relation to the full-load losses.

(11) Total losses at 800 amp.
= (380 + 360 + 372) + (3,962 + 276) = 5,350 watts.

(12) Assume the use of a standard watt-hour demand register with a scale of 10.2 kw., a gear ratio of 2,777-7/9, operating with a watt-second constant of 12,960. (Register constant = 1.)

(13) For use with Item (12) the copper loss elements must be recalibrated for a speed faster than 3.6 seconds per revolution. Required seconds per revolution

$$= \frac{K_s}{\text{Total copper loss}} = \frac{12{,}960}{4{,}238} = 3.058$$

(14) Check the time for register to repeat in the usual way, using total loss value obtained in Item (11).

(15) Total core loss at 230 volts = 380 + 360 + 372 = 1,112 watts.

(16) The core loss element must then be calibrated so that at 230 volts its torque will be equivalent to 1,112 watts.

(17) Seconds per revolution at 230 volts.

$$= \frac{K_s}{\text{Total core loss}} = \frac{12{,}960}{1{,}112} = 11.655 \text{ seconds.}$$

(18) For tests in service at other voltages, for example 225, seconds per revolution

$$= \frac{230^2}{225^2} \times 11.655 = 12.178 \text{ seconds.}$$

Calibration for Compensating Reactive Kilovolt-Ampere-Hour Meter—Assume that it is necessary to measure average monthly power factor. A standard reactive meter may be used on the secondary and a compensating meter added for reactive kilovolt-ampere-hours of the power transformer bank.

(19) The procedure is the same as for the watt-hour meter, except that the calibration of the elements is based on the reactive instead of the energy components of the losses. The required values are calculated from the data of Item (1) on page 12.

(20) The remaining calculations are the same as for the energy loss meter, substituting reactive volt-ampere values for watts. Note that the constants of the reactive meter will usually be different from those of the watt-hour meter for the same transformer bank.

(21) For the installation under consideration, the following results are obtained for the calculations described in Items (19) and (20).

Total reactive volt-amperes of core loss at 230 volts	= 8.629
Total reactive volt-amperes of load loss at 800 amp.	= 23,613
"Watt-second" constant (K_s)	= 86,400
Seconds per revolution for copper loss element at 5 amp. secondary (800 primary)	= 3,659
Seconds per revolution for iron loss element at 230 volts	= 10.127
Gear ratio (R_g)	= 4,166⅔
Register constant (K_r)	= 10

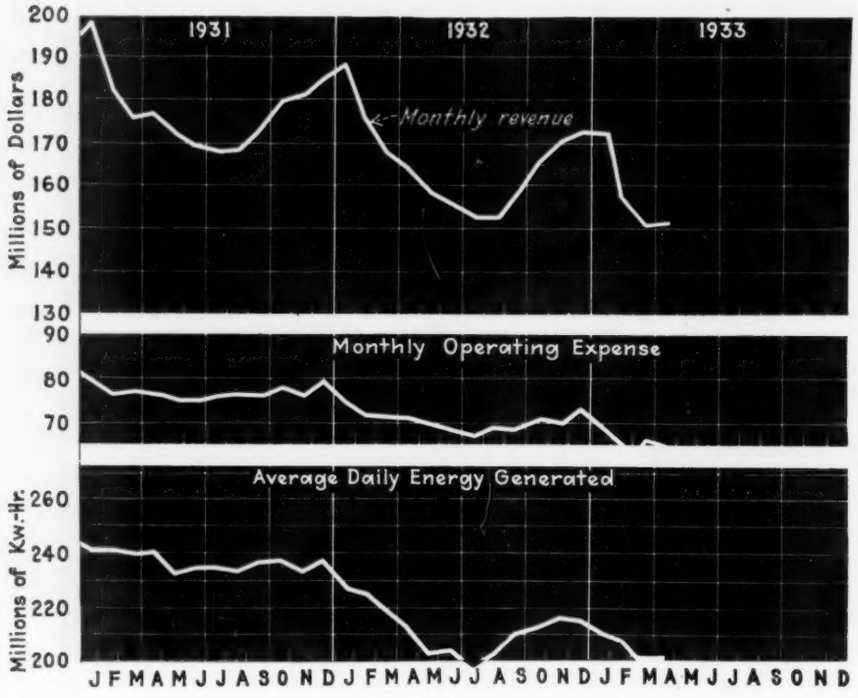
(22) Reactive compensating meters should be calibrated at approximately the average operating voltage.

April Operations Point Toward Turn

April revenue of central electric light and power stations in the United States was virtually up to the March level, unlike 1932, when there was a decline of 2 per cent. The total, $151,420,000, was 7.5 per cent less than last year, whereas the decrease in March was 9.7 per cent. The comparison reveals the beginning of the rise in receipts, which had already been foreshadowed by the gradually mounting figures on weekly energy output.

April is in line with the preceding months of the current year in bringing the lowest figures since 1927. Nevertheless, in view of the fact that production did not begin to increase until the middle of March, and of the further fact that there is necessarily a time lag between energy output and corresponding income, the interruption of the usual spring decline is in itself a favorable change.

Operating and maintenance expenses declined to $63,380,000, or 6.2 per cent less than the revised figure for April, 1932, resulting in a slightly larger net than in March.


1931
1932
1933
Millions of Dollars
Monthly revenue
Monthly Operating Expense
Average Daily Energy Generated
Millions of Kw.-Hr.
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D

The item that gives the most definite indication of a forward movement is the energy output. While the monthly total, 6,047,797,000 kw.-hr., was smaller than in March, the average daily output remained almost unchanged, in contrast with the usual seasonal decrease. The deficiency compared with 1932 has been gradually shrinking; from 9.6 per cent in February to 8.2 per cent in March and 4.7 per cent in April.

Production from water power was virtually on a parity with last year; fuel-generated energy continues lower, being off 8.5 per cent. The former constitued 48 per cent of the total, the largest fraction on record.

Considered by geographic divisions, revenue in every part of the country approached more closely to last year's than in March, and with one exception, the Southwest, the same holds true of energy output. The effect of expanding industrial operations on the use of electrical energy in the Middle West is especially noticeable. The disparity in revenue in the East North Central region shrank from 12.4 per cent in March to 8.1 per cent. In energy output the change was more remarkable—from 12.7 to 3.6 per cent. Similarly a turn in the Western metals mining industry is reflected in the statistics for the Mountain States.

Table I—Energy Output of Central Stations in the United States

Compared with Corresponding Month of Previous Year

Month 1933	Generated, Thousands of Kw.-Hr.*						Purchased for Resale	
	Total		Hydro		Fuel			
	Generated	Per Cent Inc.	Generated	Per Cent Inc.	Generated	Per Cent Inc.	Thous. Kw.-Hr.	Per Cent Inc.
January	6,535,574	— 7.8	2,828,265	— 3.8	3,707,309	—10.5	1,820,000	— 3.0
February	5,921,934	— 9.6	2,537,342	— 9.4	3,384,592	— 9.7	1,534,000	— 8.5
March	6,264,504	— 8.2	2,878,900	— 1.2	3,385,604	—13.3	1,604,000	— 6.0
April	6,047,797	— 4.7	2,936,170	— 0.5	3,111,627	— 8.5	1,596,000	+ 1.3

Table II—Regional Revenue, Energy Output, in April, 1933

Compared with Corresponding Month of Previous Year

Region	Revenue		Energy Generated, Thousands of Kw.-Hr.*					
			Total		Hydro		Fuel	
	Thousands of Dollars	Per Cent Inc.	Generated	Per Cent Inc.	Generated	Per Cent Inc.	Generated	Per Cent Inc.
United States	151,420	— 7.5	6,047,797	— 4.7	2,936,170	— 0.5	3,111,627	— 8.5
New England	15,900	— 6.1	408,481	— 4.3	275,369	— 5.7	133,112	— 1.8
Middle Atlantic	41,100	— 7.9	1,485,461	— 5.1	533,713	+ 2.1	951,748	— 9.0
East North Central	35,360	— 8.1	1,404,612	— 3.6	261,347	+15.3	1,143,265	— 7.1
West North Central	12,450	— 8.2	391,062	— 4.7	149,201	+ 1.5	241,861	— 8.0
South Atlantic	17,540	— 5.6	801,060	— 1.5	585,696	+ 7.1	215,364	—19.5
East South Central	4,810	—10.1	243,542	—11.2	207,146	—11.3	36,396	— 9.8
West South Central	7,310	— 7.2	297,076	— 8.0	24,290	+28.6	272,786	—10.4
Mountain	3,420	— 8.0	183,708	— 3.2	142,380	— 4.0	41,328	0
Pacific	13,530	— 6.3	832,795	— 5.8	757,028	— 7.0	75,767	+ 9.0

*By courtesy of U. S. Geological Survey, with deductions for operations not regarded as central-station operations.

Table III—Central-Station Financial Operations in the United States

Compared with Corresponding Month of Previous Year

Month	Total Gross Revenue from Sale of Energy*		Total Operating and Maintenanec Expense†	
	1933 Thousands	Per Cent Inc.	1933 Thousands	Per Cent Inc.
Jan.	$171,370	— 8.8	$67,760	— 8.4
Feb.	158,620	— 9.4	64,460	— 9.5
Mar.	151,920	— 9.7	64,550	— 8.7
April	151,420	— 7.5	63,380	— 6.2

*Aggregate gross revenue from consumers and from other utilities for energy for resale, involving a certain amount of duplication.

†Does not include interest, taxes, depreciation or sinking fund, with some unavoidable exceptions.

Men of the Industry

W. R. Marshall Vice-President of Westinghouse

Commercial vice-president of Westinghouse Electric & Manufacturing Company since 1930, W. R. Marshall, manager of that company's Pacific Coast division, has been made a full vice-president. Mr. Marshall, who has been with Westinghouse for 24 years, was at one time district manager for the company at Pittsburgh, being transferred to San Francisco in 1928. He is a member of the executive committee of the Pacific Coast Electrical Association and is a director of the San Francisco Electrical Development League.

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WILLIAM A. PRENDERGAST, vice-president and director of the Long Island Lighting Company, has resigned. Mr. Prendergast, for many years chairman of the New York State Public Service Commission, joined the Long Island Lighting Company in May, 1932.

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DONALD D. HOOVER has been made head of the public relations department of Northern Indiana Public Service Company. He has for some time been one of the editors of the Indianapolis *News*.

•

MILTON R. STAHL, former chairman of the Missouri Public Service Commission, has joined Commissioner John H. Porter in tendering his resignation from the state regulatory body to Governor Park. Recently supplanted by John C. Collet as chairman, Mr. Stahl's withdrawal has been rumored for some time. His term would not have expired until April, 1935.

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FRED W. HERBERT, following the dissolution of the accounting national section of the National Electric Light Association, with which he had long been associated, has opened a New York office as a consulting accountant.

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WILLIAM A. SMITH has been appointed chief engineer of the Ohio Insulator Company, division of the Ohio Brass Company, to succeed A. O. Austin, who has resigned to establish a consulting engineering practice. Mr. Smith joined Ohio Insulator in 1916 as a designing and manufacturing engineer and instituted outstanding efficiencies in clay-forming, kiln-firing and other general manufacturing processes, as well as carrying on his work of product designing. He went to the Pacific Coast in 1925 to attend to some personal interests, later returning to the O-B insulator plant, where he has been serving as superintendent of the engineering department. Mr. Smith's early experience in the electrical industry was obtained with Westinghouse, Church, Kerr, the Worthington Pump & Machinery Company and the Pacific Gas & Electric Company.

▼

A. D. Robb Selected President of Canadian Association

Alexander D. Robb, vice-president and general manager of the Canadian Niagara Power Company, who was elected president of the Canadian Electrical Association for the 1933-1934 term at the recent annual meeting of that

organization, has been connected with the utility industry in the United States and Canada for more than 30 years. Mr. Robb joined the staff of the Niagara Falls Power Company in 1902 and subsequently acted in various capacities with Canadian Niagara Falls Power, Niagara Electric Service Corporation, Buffalo, Niagara & Eastern Power Corporation and various transportation units of that group of companies.

▼

A. G. WISHON, former president and chairman of the board of the San Joaquin Light & Power Corporation, has been voted the degree of doctor of engineering by the board of curators, School of Mines and Metallurgy, University of Missouri, for his contributions to electrical development.

•

H. M. WIBLE has been appointed manager of the commercial cooking and refrigeration division of the Westinghouse Electric & Manufacturing Company. Previous to Mr. Wible's appointment, the commercial cooking and commercial refrigeration divisions were two separate departments, but with their affiliation with the merchandising department they were combined under Mr. Wible's leadership. He has been identified with the Westinghouse company for a number of years in various capacities.

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FREDERICK M. FEIKER, director of Foreign and Domestic Commerce during the Hoover administration and former editorial director and vice-president of the McGraw-Hill Publishing Company, Inc., has been engaged by the Textile Foundation to survey existing educational programs in the textile industry with a view to recommending changes which will advance the programs as may be commensurate with industry needs.

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PERCIVAL JAMES ROBINSON, city electrical and lighting engineer of Liverpool, member of the Institution of Electrical Engineers, of the Institution of Mechanical Engineers and honorary member of the Society of Civil Engineers of France, has been elected president of the Incorporated Municipal Electrical Association, England.

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R. E. SIMPSON, for the past twenty years illuminating engineer for the Travelers Insurance Company, has retired from active service with that company. Mr. Simpson, widely known in public utility and industrial fields and a contributor to society meetings on the hazards of inadequate illumination in buildings and on the highways, plans to devote his time to consultation on public illumination and industrial safety.

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EDWIN B. CUMMINGS, manager of the Oxnard district of the Southern California Edison Company, Ltd., has been named district manager at Alhambra to succeed Arthur W. Althouse, who has assumed new duties in Pasadena. M. F. RHODES, district manager at Porterville for the past six years, will succeed Mr. Cummings at Oxnard. GEORGE H. WHITNEY and L. R. QUINBY, appointed district manager at Porterville and Delano, respectively, are newcomers in the ranks of Edison managers. Mr. Whitney before his appointment as manager was assigned as a power specialist in the Porterville district and Mr. Quinby has been acting district manager at Delano for some time.

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PETER F. DOLAN has been appointed superintendent of the wire department of the city of Boston, succeeding Walter F. Burke, who recently retired after many years of service. Mr. Dolan was graduated from the Massachusetts Institute of Technology in electrical engineering in 1893. With the exception of the period between 1908 and 1911, when

he engaged in electrical contracting, his entire career has been identified with the municipal wire department. For the past twelve years he has served as acting superintendent during absences of the head of the department.

•

L. G. PACENT, electrical and radio pioneer, engineer and inventor, has organized a private consulting engineering firm with offices in New York City and engineering laboratories at Little Neck, L. I. Mr. Pacent will continue as president and director of the Pacent Electric Company, but will devote most of his time to his new company, the Pacent Engineering Corporation, on patent development and research, industrial reports, special investigations, market analysis, etc. He is a past-president and fellow of the Radio Club of America, a fellow of the American Institute of Electrical Engineers and a member of several other technical societies.

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Directory of Electrical Associations

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AMERICAN ENGINEERING COUNCIL. Executive secretary. L. W. Wallace, 744 Jackson Place, Washington, D. C.

AMERICAN INSTITUTE OF CONSULTING ENGINEERS, INC. Secretary, P. W. Henry, 75 West St., New York, N. Y.

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CANADIAN ENGINEERING STANDARDS ASSOCIATION. Secretary, B. Stuart McKenzie, Room 3064, National Research Council Building, Ottawa, Ont.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION (international body formed of 26 national electrotechnical committees). General secretary, C. le Maistre, 28 Victoria St., Westminster, London, S. W., England.

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MISSOURI ASSOCIATION OF PUBLIC UTILITIES. Secretary N. R. Beagle, Jefferson City, Mo.

THE MISSOURI VALLEY ELECTRIC ASSOCIATION. Director, Thorne Browne, 1527 Sharp Building, Lincoln, Neb.

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